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Engineering News-Record

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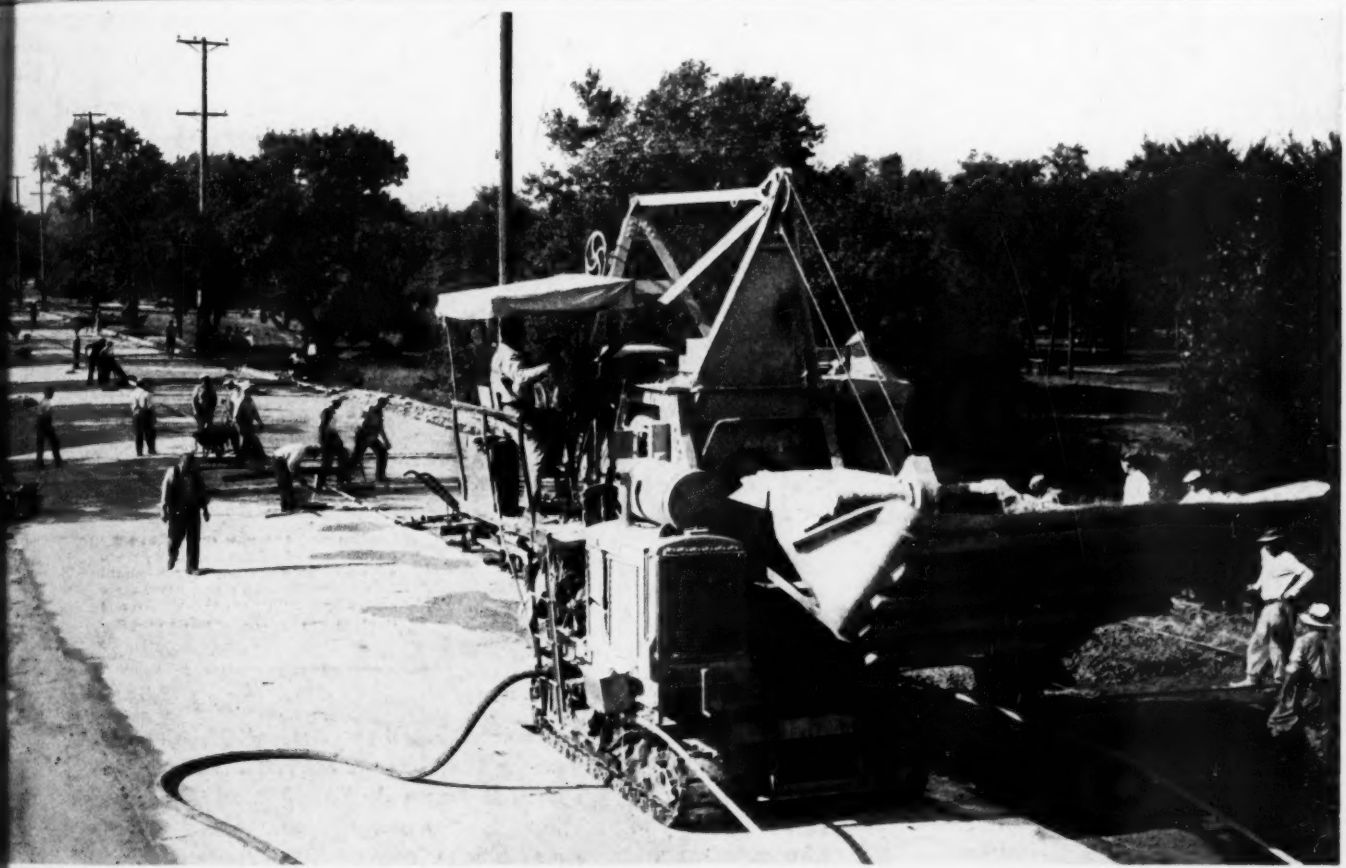

Street construction scene in Minneapolis where day-labor operations have been used for 33 years. The superintendent of street paving, E. F. Campbell, has written for this issue the first of two articles on Minneapolis methods.

IN THIS ISSUE:

Sewage Disposal for the Nation's Capital

BY FRANK A. MARSTON

Economic Sizes of Pressure Conduits

BY JULIAN HINDS

ALSO

The Problem of Homes on Wheels *Reviews of Engi*

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The Cities Build to New Standards

IN a recent issue this journal quoted an observation by Professor William F. Ogburn, reported in *Public Management*, to the effect that growing cities do not anticipate in their budgeting practice the needs of growing populations while declining cities fail to anticipate the diminishing needs of declining populations.

So far as concerns the second condition, two explanations leap to mind. One is that a large part of the cost of public services consists of fixed charges that cannot be readily reduced and of operating costs rendered more or less inflexible by the self-perpetuating tendency of the many office-holders who, once on a public payroll, acquire vested rights to public support.

The other is that distinctively American local pride that shrinks from admitting that the town no longer is headed for bigger things. He would be a hardy public servant indeed who would admit publicly that his city is on the toboggan. He would be fortunate to save his treasonable head from the block of public indignation. American cities take continuous growth for granted and frequently their citizens must pay dearly for their faith.

BUT the other side of the picture sketched by Professor Ogburn shows us the same influences operating in the opposite sense. The same zealous custodians of the public pride, who condemn any intimation that their city is slipping, are prone to crack down severely on the public servant who tries to anticipate its normal growth. That is true in many departments of public service; it is one of the reasons why so many public facilities lag behind the need. Conscientious engineers in federal, state, county and city service can cite many heart-breaking failures to win support for worthy projects designed to anticipate manifest needs.

But, however, all this may work out in the long run, it looks now as though our city engineers will have their work cut out for them for some time to come if they are to keep their facilities up to the mark.

For those needs are not measured by population statistics alone. The caliber of public service demanded by the modern city-dweller is not static. As with every other phase of modern living those standards tend constantly to rise.

In the same issue of *Engineering News-Record* that carried Professor Ogburn's comment appeared a series of articles telling how Los Angeles has been rebuilding its public schools to higher structural standards. The people of that city demand that their children be not exposed to the hazards of general collapse from earthquake, a need that was brought forcibly home to them by the Long Beach disaster in 1933. This is typical of rising standards that are quite independent of population growth or decline.

What is true of public school buildings in Los Angeles is equally true of other municipal services in other cities. We are establishing higher standards of water supply that will take into account quality as well as quantity; higher standards of sewerage that will eliminate the unpleasant as well as the unhygienic aspects of stream pollution; higher standards of street location, design and maintenance that will contemplate convenience and safety as well as capacity to pass the traffic; higher standards of public recreation that will consider aesthetic values as well as the need for children's playgrounds.

TURN where we will, we find the people of our cities demanding better service as well as more services; they seek higher standards of community living as well as of personal living.

During the depression many projects designed to meet such demands were shelved. It is true that through federal aid many works were undertaken that otherwise might not have been, but it is not true that these constituted any excess over needs. In many respects the cities actually lost ground in their public facilities even during the period of so-called "public spending."

So, today, confronted by the double necessity created by this deficiency and by the rising standards of urban living, our cities and their engineers are embarking on new programs for municipal betterment. The indications are that for some time to come municipal engineering and construction will be an exceptionally busy sector in the general revival of engineering and construction activity.

Willard Chevalier

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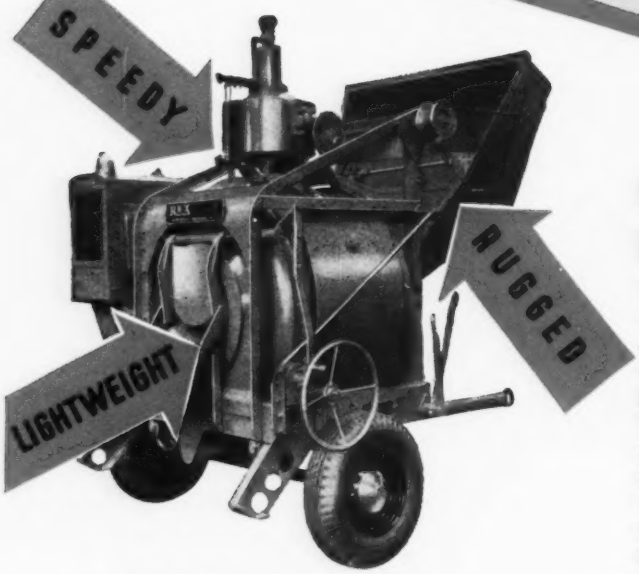

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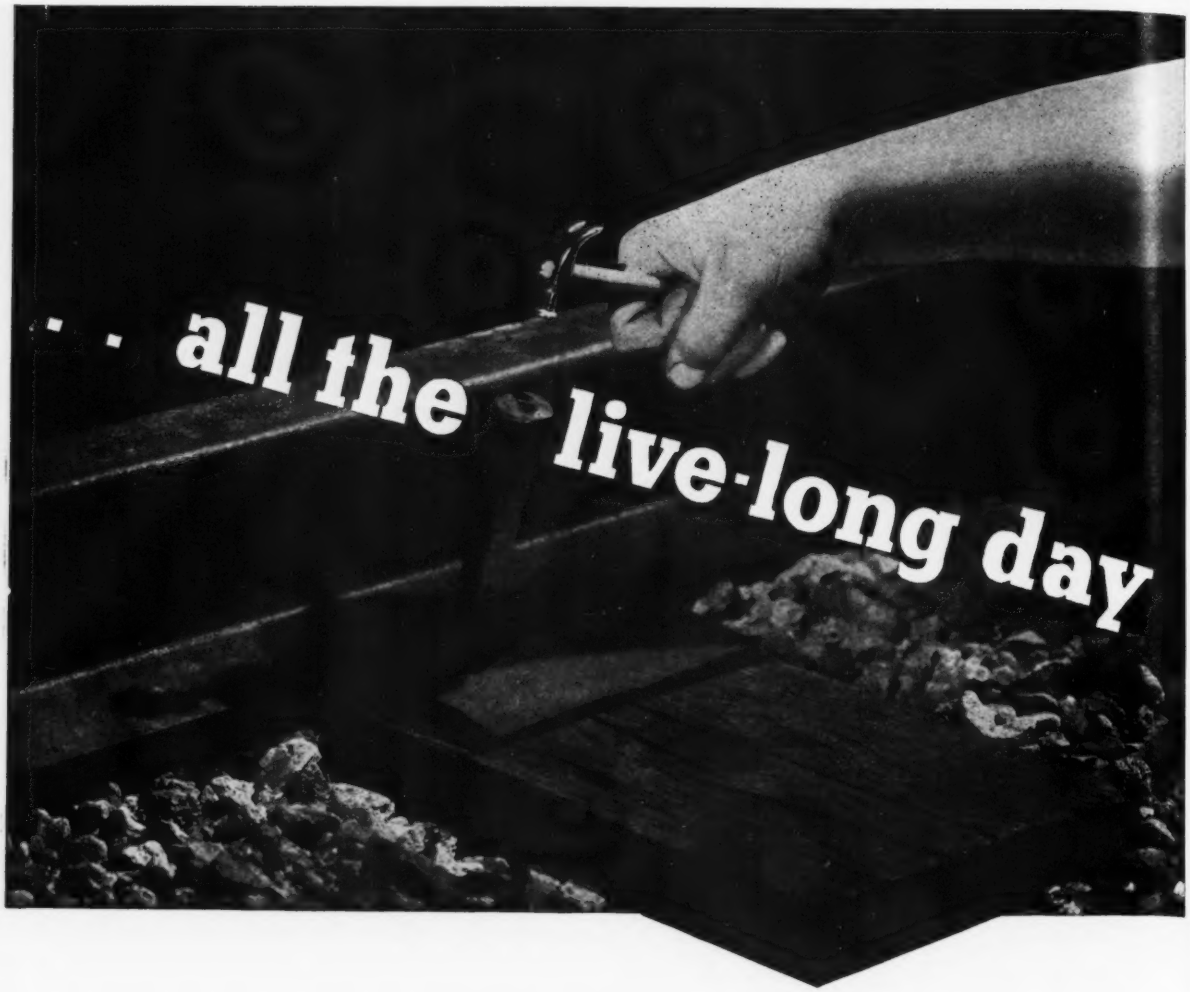
■

***Longest Lighted Highway*— More than 18 miles of lighted roadways are used on the San Francisco-Oakland Bridge and its approaches, giving it the distinction of being the premier highway lighting installation in the country. What did it cost? What will it cost to operate? What lights are used, how many and where? These questions, which occur again and again in current discussions of lighting and highway safety, will be answered in an article in next week's issue.**



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ENGINEERING NEWS-RECORD

March 25, 1937

Sewage Disposal For the Nation's Capital

Pollution of the Potomac River will be greatly lessened when the 130 m.g.d. primary sewage treatment and sludge digestion plant for the District of Columbia goes into operation this spring.

By Frank A. Marston

Metcalf & Eddy, Consulting Engineers, Boston, Mass.

CONSTRUCTION WORK has been practically completed on the 130 m.g.d. disposal plant that will provide sedimentation for all the sewage in the District of Columbia that is now pouring untreated into the Potomac River. The new plant, to be placed in operation this spring, includes such features as grease separation, sludge digestion and utilization of gas for power generation, and elutriation of sludge prior to dewatering in vacuum filters. The project is costing about $3,600,000 and has been financed with a PWA loan and 30 per cent grant. The design of the plant was predicated on an investigation of the sewage disposal problem of the District of Columbia made in 1933 by a board of sanitary engineers, composed of Harrison P. Eddy, Samuel A. Greeley, and the late John H. Gregory.

Sewage of the district is collected in combined sewers and it has been pumped directly into the Potomac River through two submerged outlets. During low river flow the river shows marked evidence of pollution farther downstream than Mount Vernon, and the water at Alexandria is badly polluted. The board's studies indicate that to maintain 50 per cent saturation of dissolved oxygen in the river waters, a dilution of about 7.3 cu. ft. per sec. per 1,000 of population load is required for the untreated sewage. On the basis of present population, the river discharge actually is below the critical quantity during summer months.

A survey made by the U. S. Public Health Service in 1932 showed an average bacteria pollution of 470 B coli per c.c. in the river opposite Fort Foote, which is about four miles below the present sewer discharge. Some decrease in bacteria occurs farther down the river, but a survey by the Public Health Service in 1913-14 would indicate that they persist in considerable numbers at least 55 miles from the sewer outlet.

Treatment recommendations

As a result of their investigation the board of sanitary engineers recommended (1) that a sedimentation process be used during the six cool months of the year and (2) the adoption of the activated-sludge type of treatment to provide a high degree of purification during the remaining months. The present plant represents the first step toward eventual fulfillment of these recommendations.

The plant will handle the discharge

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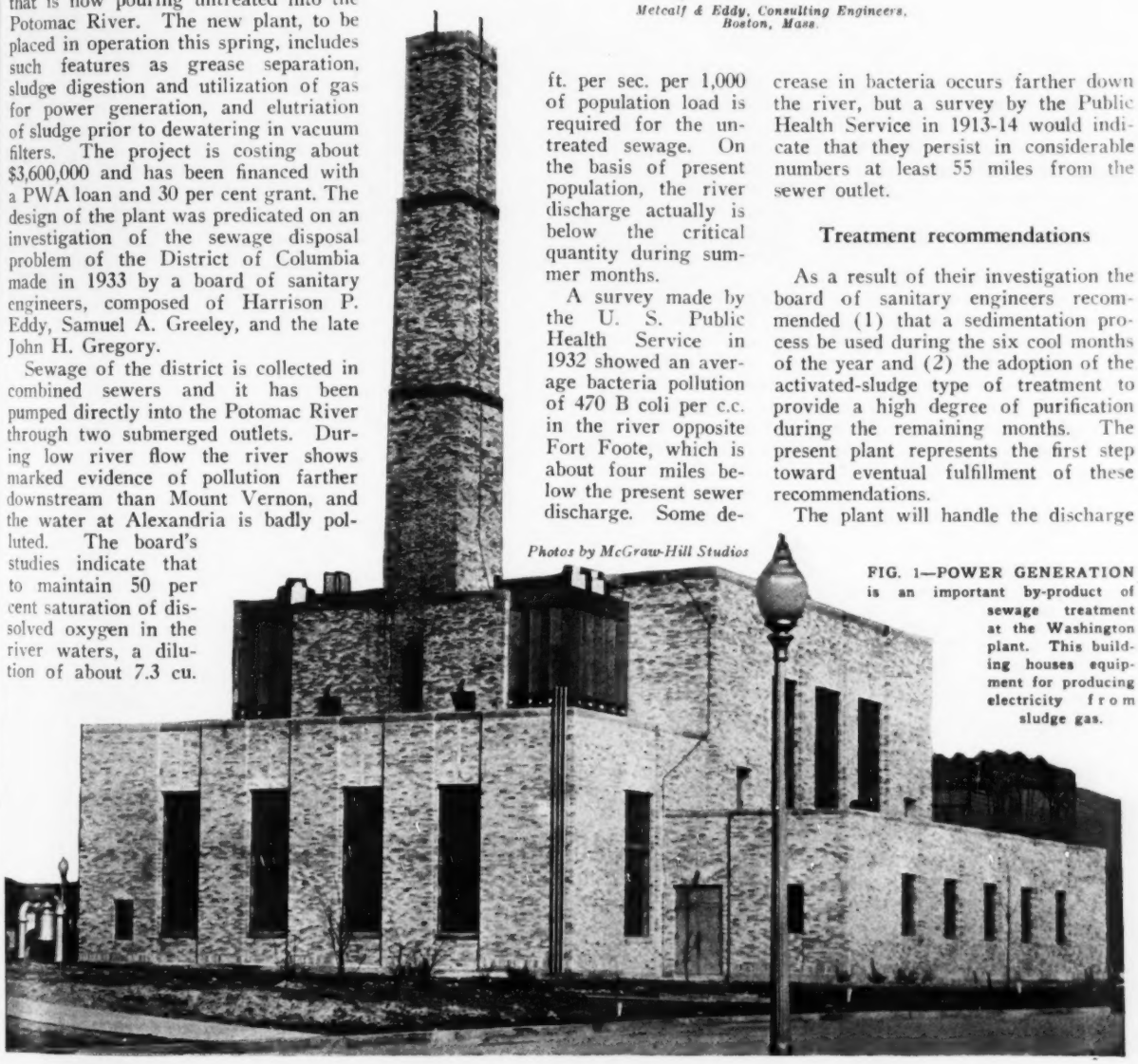


FIG. 1—POWER GENERATION is an important by-product of sewage treatment at the Washington plant. This building houses equipment for producing electricity from sludge gas.

of the entire district (population 487,000 in 1930) together with sewage from a portion of the Washington Sanitary District. Design capacity is sufficient to serve a population of 650,000, estimated to be reached about 1950; the average flow contemplated is 130 m.g.d. The purification process will effect 45 per cent removal of suspended solids and about 35 per cent reduction of biochemical oxygen demand.

The plant site is about one mile south of the old outfall sewer discharge near Bolling Field. Sewage will be diverted at this point through a new semi-elliptical sewer 10-ft. 3-in. by 10-ft. 3-in. that terminates in a pumping station at the plant. Here the sewage will be lifted 20 ft. to flow into grit chambers and then through a venturi meter into grease separation tanks. Following a short period of aeration (3 to 9 min.) to cause flotation of grease, the sewage passes into the settling tanks for two-hour detention before being discharged into the river.

Sludge, grease and scum are to be digested and by-product gas will be collected in a gasholder for use as fuel in a 1,200-hp. engine-driven electric generator unit. Digested sludge is to be elutriated with river water prior to chemical conditioning and dewatering in vacuum filters. The dry cake will be transported by either truck or railroad for land disposal at Lorton, Va., about 35 miles away.

Pumping station details

In the pumping station, there are four pumps (with space for two more) which will lift the sewage from the suction well to the grit chambers. The nominal capacities of the pumps are: one at 80 m.g.d., two at 60 m.g.d. and one at 40 m.g.d. They are vertical-shaft, bottom-suction, constant-speed units, driven by synchronous motors. The discharge pipe of each pump is equipped with a hydraulically operated butterfly valve, with mechanism for either

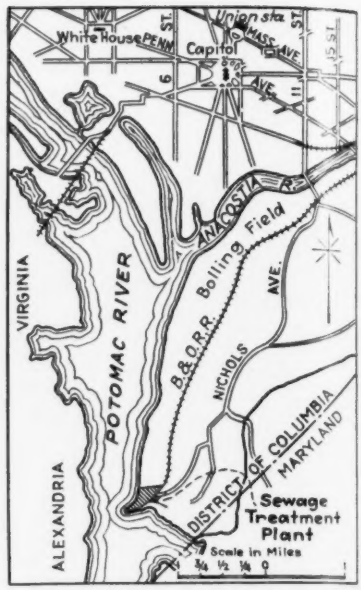


FIG. 3—SITE OF THE DISPOSAL WORKS on the east bank of the Potomac River, 7 miles south of the nation's capitol.

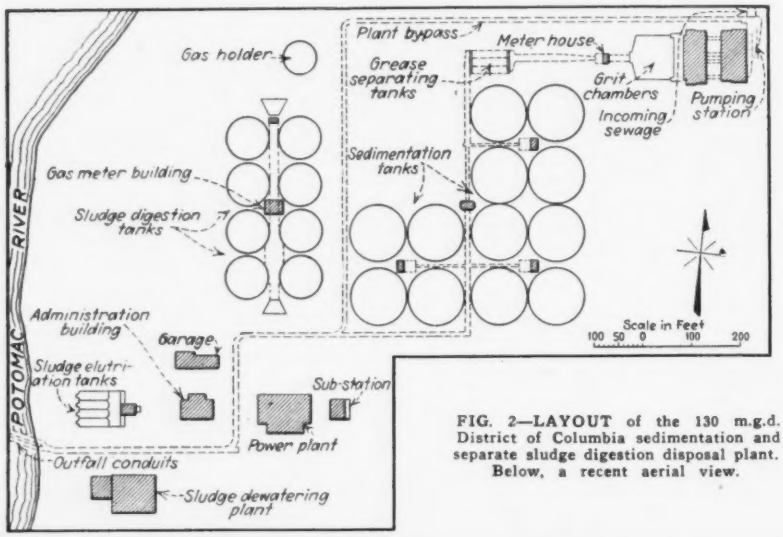
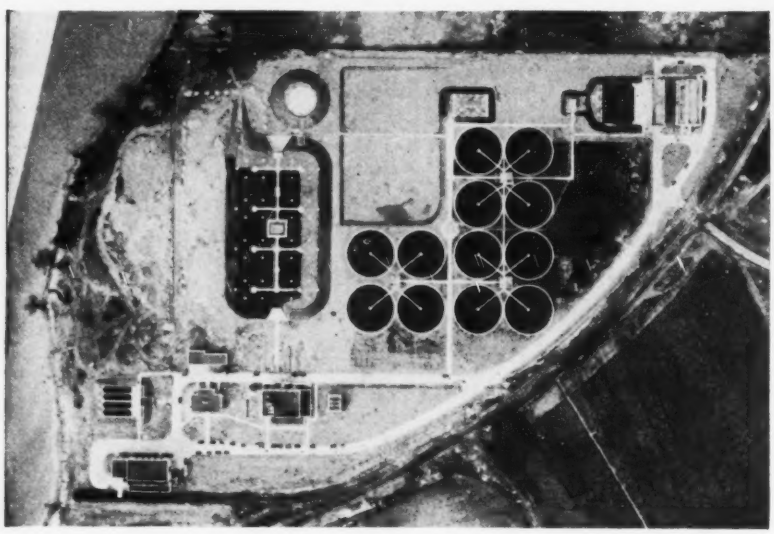


FIG. 2—LAYOUT of the 130 m.g.d. District of Columbia sedimentation and separate sludge digestion disposal plant. Below, a recent aerial view.

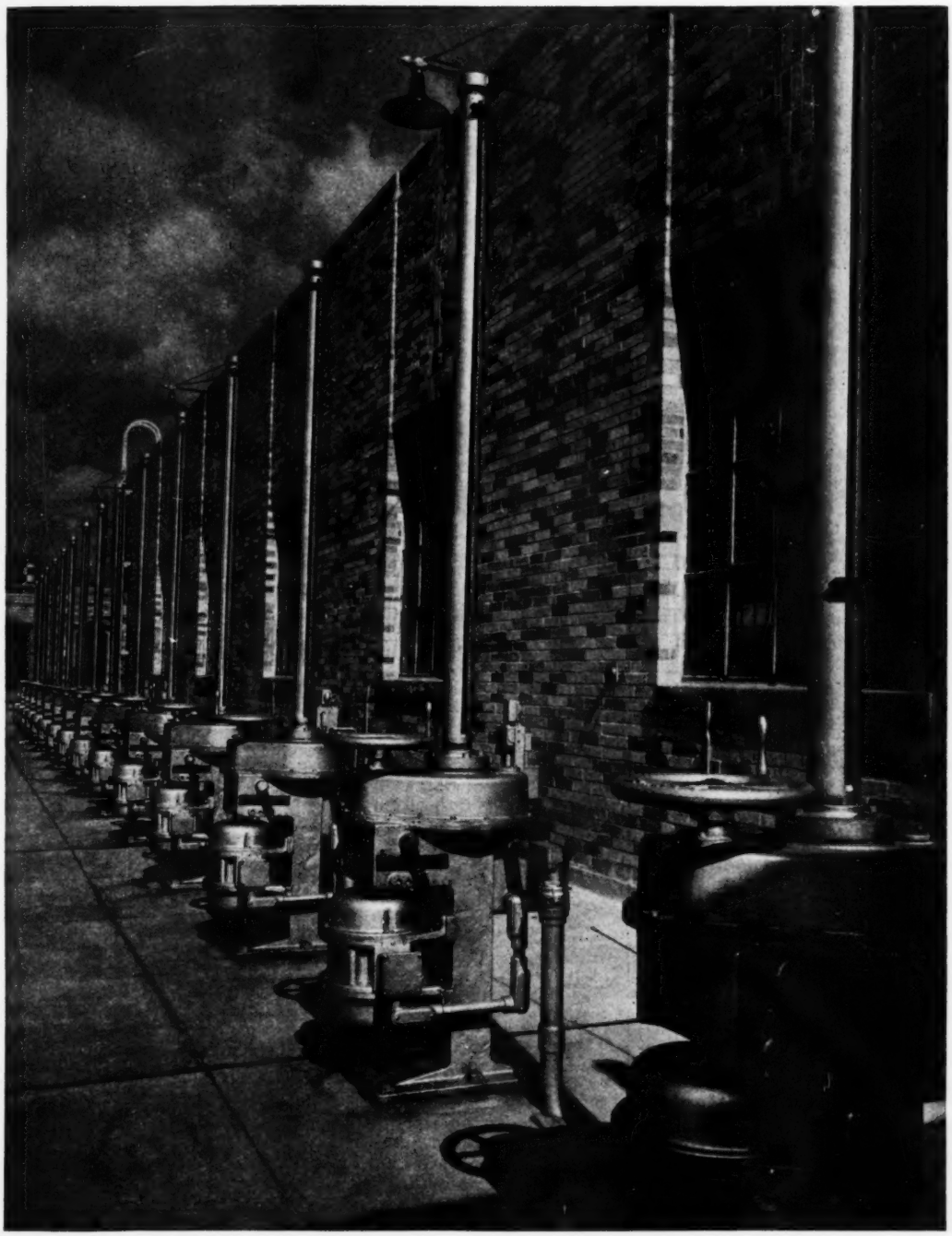


manual remote control or automatic operation. When the control devices at the switchboard are set for automatic operation, the valve opens when the pump develops sufficient head to overcome the static head in the discharge pipe beyond the valve. There is a separate pneumatic-pressure water-storage system, capable of operating each valve once in the event of an interruption to the water supply of the plant.

The pumps discharge through individual conduits into an influent channel common to all grit chambers. This channel is equipped with a scraper-conveyor to remove any deposited material.

There are eight grit chambers, each 10 ft. wide and 80 ft. long, with a normal effective operating depth of 2.5 ft. The normal velocity of flow through the chambers will be one foot per second; this will be controlled by motor operated sluice gates at both ends. Deposited grit will be scraped to the inlet end, elevated by screw conveyors, and deposited in buckets which will be dumped either into trucks or a storage hopper. The grit chambers are covered and provision is made for drawing air from the head house into the chambers and discharging it through the stack at the power plant.

From the grit chambers the raw sewage passes through a venturi meter 9 ft. in diameter at the inlet and 4.5 ft. at the throat. It is designed for operation with a minimum flow of 30 m.g.d., a normal rate of 112 to 170 m.g.d., and a maximum flow of 300 m.g.d. The pressures at the inlet and throat will be transmitted mechanically by means of floats to a flow-meter mechanism in the superstructure of the meter vault. This mechanism includes a rate-of-flow indicator and an electric transmitting device



SENTINELS OF SEWAGE

Motor-operated sluice gates controlling flow into the grit chambers of the Washington, D. C., treatment plant.

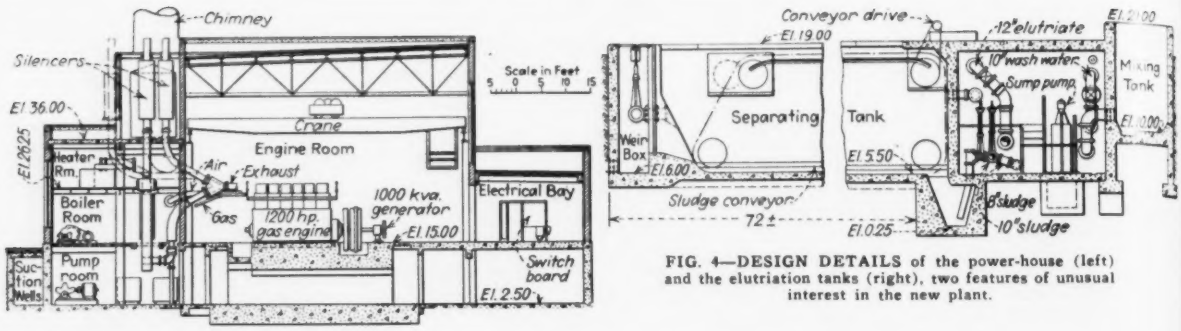


FIG. 4—DESIGN DETAILS of the power-house (left) and the elutriation tanks (right), two features of unusual interest in the new plant.

by means of which the flow rate will be relayed to indicators in the pumping station and the grit-chamber head house, as well as to a register-indicator-recorder in the administration building.

Grease separation by air

From the venturi meter the sewage will flow into three aerated grease-separating tanks. Each tank is 15 ft. wide, 78 ft. long, and 15.5 ft. in maximum water depth and is equipped with two rows of diffuser plates along one side. The tanks are covered and are furnished with valves, accessible from the roof, for regulating the air supply. Air, after being used for agitation, will be drawn out through the channels leading to the sedimentation tanks and may be discharged through the power-plant stack.

With all three tanks in operation the detention period in the grease-separating units will vary from 3 min. at maximum rates of flow to 9 min. at minimum rates of flow, with an average of 4 min. for a flow of 130 m.g.d.

Circular sedimentation tanks

After the grease-separating treatment, the sewage flows into 12 sedimentation tanks, which are arranged in groups of four around three control houses. These tanks have an inside diameter of 106 ft. and an average effective depth of 14 ft. Their combined capacity is 11.2 m.g., which will provide a detention period of 2 hr. for an average flow of 130 m.g.d.

Sewage will be conducted to the tanks through concrete conduits so proportioned that the average velocity in each conduit will be not less than 1 ft. per sec. In the conduits above the flow line there will be sufficient space for the passage of the air blown through the sewage in the grease-separating tanks. This air will be removed from the conduits by an exhaust fan and discharged into the exhaust air line from the grit chambers.

Sewage will enter the sedimentation tanks at the center through a vertical pipe 4 ft. in diameter at its upper end, and the effluent will be discharged over a circumferential weir. Each tank is equipped with a clarifier mechanism for scraping the settled solids to the center for discharge into the digestion tanks. One arm of the sludge cleaning mechanism supports a skimming baffle to remove scum which will be pumped into the sludge-digestion tanks.

The effluent outfall in the Potomac River consists of twin pipes, each 7.5 ft. in dia., made of precast reinforced concrete laid in part on timber cradles with pile supports. The outlet conduits, 900 ft. long, will discharge the effluent at a depth of about 15 ft. below mean low tide.

PLANT HIGHLIGHTS

Capacity:	**130 m.g.d.**
Treatment:	**Grit removed, grease separation, sedimentation; sludge to be digested, elutriated, dewatered on vacuum filters and disposed on land.**
Purification:	**Suspended solids removal, 45 per cent; B.O.D. reduction, 35 per cent.**
Power Production:	**By-product sludge gas used as fuel to operate 1200 - hp. internal combustion engine driving a 1000 kva. generator.**
Cost:	**$3,600,000.**

Equipment for pumping sludge and scum from the sedimentation tanks to the sludge-digestion tanks is located in the control houses. The pumps are of the duplex plunger type and their capacity may be varied from 20 to 100 gal. per min. against a maximum total head of 40 ft. There is one pump for each tank, but they are cross-connected in such a way that each tank may be served by either of two pumps that discharge into a common sludge line leading to the digestion tanks.

Sludge-digestion tanks

Raw sludge and scum will be pumped either intermittently or continuously to the digestion tanks, of which there are eight—four on either side of an operating gallery. Each tank is 84 ft. in dia. and 24 ft. in depth at the side wall. The tank bottom is an inverted cone with a depth of 14 ft.; the slope of the bottom is 1 vertical on 3 horizontal. The eight tanks have a combined capacity of 1,140,000 cu. ft., equivalent to 1.75 cu. ft. per capita. The tanks are covered with fixed roofs, under which gas is collected. Raw sludge will be added to the tanks about 10 ft. below the normal water level and digested sludge will be withdrawn from the center of the bottom. Overflow liquor will be discharged into the influent of the sedimentation tanks.

Each tank is equipped with hot-water heating coils (effective area of 2,325 sq. ft.) and pipes with flushing nozzles. The latter, located around the periphery of the tank at the base of the side wall as well as at the end of the sludge draw-off pipe, will be of assistance in drawing sludge and in removing consolidated deposits.

In the operating gallery there are four horizontal centrifugal sludge pumps each with a rated capacity of 250 gal. per min. against a total dynamic head of 45 ft. and capable of passing a 3-in. sphere. Under normal operation, the pumps will draw digested sludge from the digestion tanks and discharge it into the elutriation tanks. The pumping facilities are so arranged, however, that sludge can be withdrawn from any tank and discharged into the same or any other digestion unit, thus permitting recirculation and two-stage or multiple-stage operation. Furthermore, scum or top liquor can be drawn and pumped into any digestion tank or into the elutriation tanks.

There are two venturi-meter rate controllers which will control and measure the rate of withdrawal of digested sludge. Only one controller will be in use at any given time, the other unit being a spare. The apparatus is intended to provide close measurement and control with flows of 100 to 400 gal. per min. and can be used for a rate of flow as low as 60 gal. per min.

A gas holder of the double-lift, water-seal type, with a total capacity of 150,000 cu. ft., has been installed to provide storage facilities. The gas pressure afforded by the upper lift only

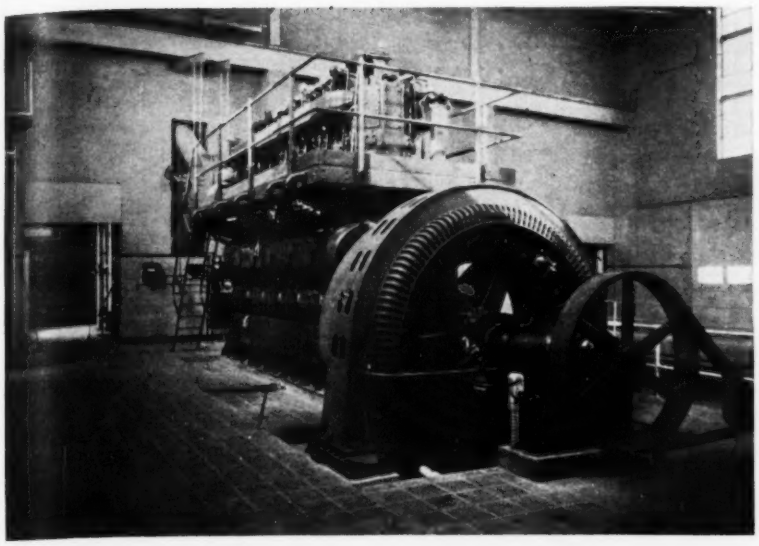


FIG. 5—SLUDGE GAS operates this 1,200-hp. internal combustion engine directly connected to an electric generator which will supply a portion of the power required in the plant. Exhaust gases from the engine pass through a silencer before reaching the atmosphere.

is equivalent to 6 in. of water, and the pressure due to both upper and lower lifts amounts to 11.4 in. of water.

Elutriation of sludge

In order to minimize the difficulties and cost of dewatering sludge an elutriation or "washing" process will be used. This consists simply of mixing sludge with relatively clean water for the purpose of washing out compounds which would otherwise re-act and partly nullify the action of chemicals used for conditioning the sludge prior to dewatering. The process has been developed and patented by A. L. Genter of Baltimore, Md.

Under ordinary conditions, water for the elutriation process will be pumped from the Potomac River. Occasionally, when the river level is too low, it will be necessary to use settled sewage for wash-water purposes. Digested sludge and elutriating water will be thoroughly mixed in two aerated mixing tanks, each 6 ft. wide, 24 ft. long and 8 ft. deep, a row of diffuser plates being installed at the bottom of each tank, along one side. The mixing tanks have a total net capacity of about 2,200 cu. ft.

From the mixing tanks the mixture of sludge and wash water will be dis-

FIG. 7—VACUUM FILTERS for dewatering digested sludge after it has been elutriated with river water and conditioned with ferric chloride. The 24-in. belt conveyors on each side of the center aisle remove the dried sludge as it falls off the 11.5-ft. dia. filter drums.

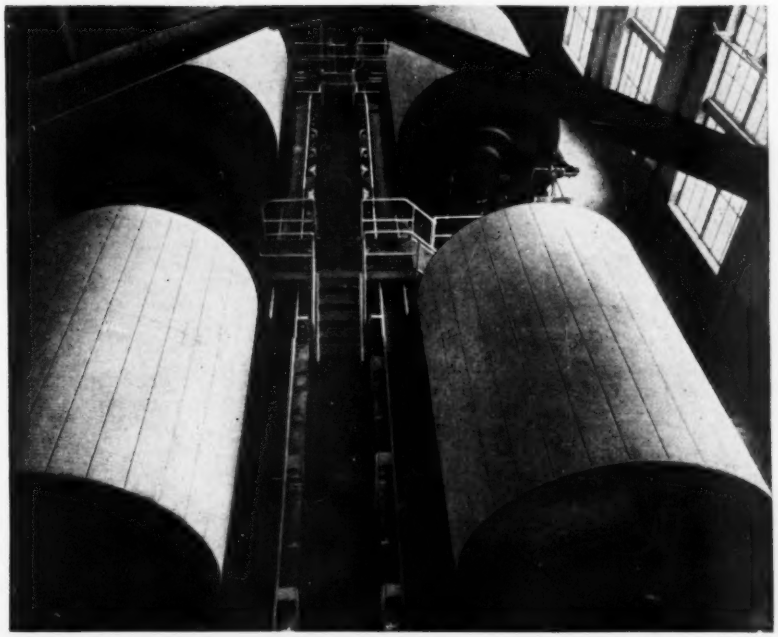
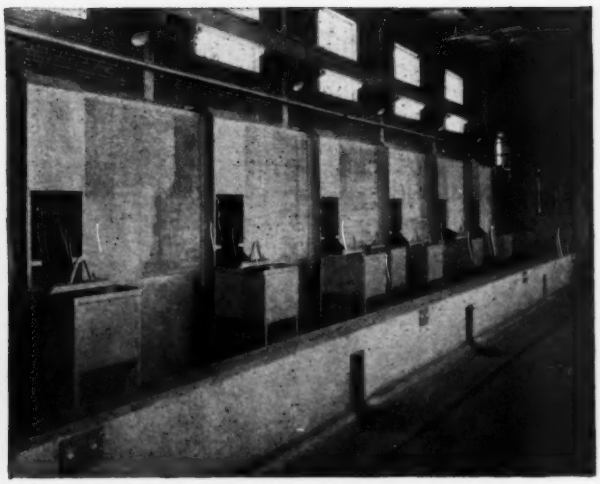


FIG. 6—GRIT HANDLING EQUIPMENT showing (left) the screw conveyors which elevate the deposited material from the chambers and discharge it into buckets (right). The buckets are picked up by an overhead crane and dumped into trucks.



charged into the separating tanks, where the sludge and elutriate (supernatant liquor) will be separated. These tanks are four in number, each 16 ft. wide, 60 ft. long and 11.7 ft. in average effective depth. The total water capacity of the four tanks is about 50,000 cu. ft.—equivalent to the normal daily production of sludge plus two volumes of elutriating water. Tank capacity was based on the assumption that the elutriation process will be in operation five days a week.

Elutriated sludge will be scraped into hoppers at the influent end of the separating tanks and pumped to the sludge-dewatering plant. The elutriate will be collected in a suction well at the dewatering plant and pumped automatically into the inlet of the sedimentation tanks.

Sludge conditioning

The sludge-dewatering equipment is designed to reduce the moisture content of the sludge from 94 to 75 per cent, thus changing it from a liquid to a cake. The first step in this process is to condition the sludge with chemicals to assist the formation of a suitable cake on the vacuum filters.

Sludge pumped from the elutriation separating tanks will discharge into a revolving bucket-like feding devise which empties into the chemical mixing tanks. There are two tanks and a feeder for each, the speed of which is controlled through an automatic, electric speed-changing device operating from floats in the sludge-filter tanks. Each mixing tank serves two filters and has a capacity of 2,000 gal. Chemicals will be mixed with the sludge by means of paddle-wheel agitation during a 5 min. detention period.

Ferric chloride will be used as the conditioning agent. The chemical solution will be stored in two cylindrical storage tanks, each 9.5 ft. in dia., 16 ft. long and capable of holding 8,000 gal. From storage the solution will be pumped to two small supply tanks which will dose the mixing tanks in proportion to the flow of sludge. Provision is also made for the application of lime to the sludge in the mixing tanks by means of two dry-feed machines, each with a capacity of 12.5 lb. per min.

Vacuum filter units

The condition sludge will be discharged into four sludge-filter tanks, in each of which a cylindrical vacuum filter is partly submerged. Each filter drum is 11.5 ft. in dia., and 14 ft. long, with an effective area of 500 sq. ft. The sludge level in the tanks will be maintained at a pre-determined height by a float control to promote the maximum filtering efficiency.

The sludge cake will be discharged on a belt conveyor, 24 in. wide, which will transport it to a loading platform. At this point it can be dumped either into trucks below, into a storage space, or upon a cross-conveyor for loading into railway gondolas.

The filtrate, removed from the filters with the air in the vacuum system, will be discharged into two receivers, from which the air will be drawn by dry vacuum pumps. The filtrate will be pumped into the effluent conduit.

The following equipment is housed in the power-plant building: a gas-engine-driven electric generating unit, designed to operate on sludge gas and to furnish a portion of the electric power required at the treatment plant; two electric-motor-driven pressure blowers, to furnish air for the grease-separation and elutriation processes; an exhaust fan for the plant ventilating system and an induced draft fan for the auxiliary boiler, both electric-motor-driven; air-cleaning equipment; waste-heat and auxiliary-fuel boilers and heat-exchange equipment, for heating the water circulated to the sludge-digestion tanks as well as for making steam to heat buildings; and miscellaneous equipment, such as pumps.

The gas engine is a 1,200 hp., 6 cylinder, internal combusion machine designed to operate on sludge gas. The direct-connected generator is of the revolving field, synchronous type having a capacity of 1,000 kva. This unit together with the electrical control equipment is designed to be operated in synchronism with the public utility central station source of power or as an independent unit carrying a portion of the plant load.

Purchased electric power (3 phase, 60 cycle, a.c.) is delivered through two parallel feeders at a primary voltage of 13,200 volts. It is then transformed to 2,200 volts for the main sewage pump motors and to low voltage for other plant uses. Storage batteries have been installed to furnish auxiliary power for operating switch gear and for emergency lights in case of power interruptions.

The District of Columbia sewage treatment plant has been designed and built under the direction of Col. Dan I. Sultan, engineer-commissioner, and Capt. R. E. York and Capt. D. G. Shingler, successively, as assistant engineer-commissioners, Corps of Engineers, U. S. Army; for the district, J. B. Gordon is director of sanitary engineering, Harold A. Kemp superintendent of design and construction, and Elwood Johnson resident engineer. The detailed drawing and specifications for all but the administration building and the outfall conduits were made by Metcalf & Eddy, with Harrison P. Eddy, Samuel A. Greeley and the late John H. Gregory as consultants. The administration building was designed by the municipal architect and the outfall conduits by the department of sanitary engineering of the district.

Paint for Seawater Concrete

PROTECTION for concrete surfaces where there is exposure to seawater has been found desirable on some of the waterfront structures erected and maintained on San Francisco Bay by the Board of State Harbor Commissioners. Although monolithic concrete ordinarily can be so placed that density of the surface is sufficient to prevent entry of seawater into the body of the material, on some precast concrete there is an advantage in an elastic, impervious coating, the board believes. Typical of this are long concrete piles which are subject to flexure in handling. Sometimes minor accidents in handling piles result in minute cracking. If cracking occurs in that portion of the structure which ultimately will be between low- and high-tide levels there is a real advantage in having the surface protected by an impervious coating.

Concrete structures in the Bay are therefore treated with a protective coating that is the result of tests carried on for many years by the testing department of the board. It is a compound of roofing asphalt with a melting point of not less than 150 deg. F. and 10 per cent of raw China wood oil. The compound is applied hot (about 250 to 300 deg. F.) and may be applied with a spray gun.

The coating does not harden and become brittle, but even after years of service retains a sufficient elasticity to prevent cracking or peeling off. The oldest applications on the San Francisco waterfront, now in service for 16 years, are still in satisfactory condition.

For warmer climates it has been suggested that a somewhat different percentage of the two ingredients might be desirable. The governing consideration on this point is said to be the melting point of the mixture. In the proportions mentioned the 150-deg. melting point of the compound is brought down to about 110 deg. F. by admixture of the China wood oil. The melting point should not be so low that the coating will melt and "run" under air temperatures that may be expected in the location where it is in service. Prior to application it is desirable to treat the surface with a priming coat to pick up the loose particles and fill the pores. A very satisfactory primer can be made from the compound described in the foregoing by thinning it with a cut-back of some sort.

Frank G. White is chief engineer of the California State Harbor Commission and A. A. M. Russell is testing engineer. The compound described was developed by Mr. Russell.

Day-Labor Street Paving

Minneapolis, a city of nearly a half-million population, considers its organization, plant and methods of day-labor paving highly successful—Efficiency of the set-up credited to extensive application of civil-service in paving organizations.

By E. F. Campbell
Superintendent of Paving, Minneapolis, Minn.

MINNEAPOLIS is exceptional in doing all city construction with its own engineering and construction forces and equipment. This policy of city day-labor construction is now nearly 35 years old. In this full generation of development what has practice come to be? For the vital work of street paving the answer is given in this article and another on pavement types, materials, construction and upkeep that is to follow. As a record of paving practice quite different from that of most large cities these articles justify attention.—EDITOR.

MINNEAPOLIS is the largest city that does all its paving by day labor. It began day-labor work in 1902 and in the generation that has since elapsed a paving organization and plant and a technique of design and construction have been developed that are a source of city pride. The history of this development includes many contentions with critics of the day-labor policy besides the usual problems of organization and engineering practice but a review of troubles meets no purpose of the present and this and a following article tell only how Minneapolis now provides its residents with paved streets. The plan and methods have a novelty that is of interest to cities that do their paving by the more common policy of contract construction.

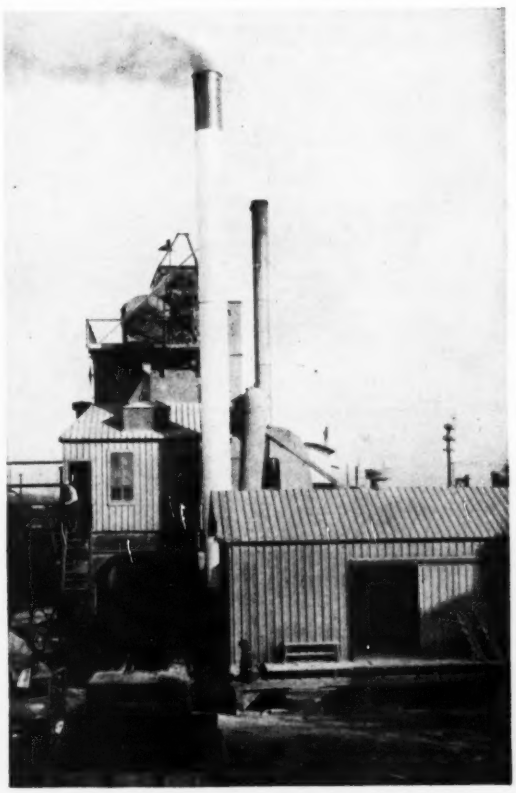
Two financing plans

How money for paving is obtained is the first question in any city. Minneapolis is governed by a mayor and a council of 26 aldermen. The council is divided into committees to expedite the numerous matters and activities subject to council action, and all questions relating to paving are handled by the paving committee, or a delegated committee, and are submitted for final decision to the council as a whole.

The city engineer recommends a program of streets to be improved, the type of paving to be used and the estimated cost of construction. Upon approval by the committee and passage by the council, proper legal steps are taken to secure the necessary funds under one of two plans. Incidentally considerable paving work has been done during the past three years by the city, under the day-labor system with federal funds allocated to it by the state highway department, but this is not normal practice and is probably temporary only.

Five-Year Law—The city has created a permanent-improvement revolving fund from which projects under the so-called five-year law are financed. The taxpayer is assessed for the actual cost of the project according to the abutting frontage of his property. Payments are divided into five equal yearly installments and are credited to the revolving fund. Interest is charged at the rate of 5 per cent on the unpaid balance. Portions of the pavement not assessable to abutting property, such as street intersections, intersecting streets and alleys and city-owned property, are paid for from a fund financed by the sale of bonds.

FIG. 1—ALL ASPHALT MIXES for Minneapolis street work are produced by a two-unit city-owned asphalt plant.



Elwell Law—The Elwell law is a state law relating to the acquisition of lands for streets, parks and parkways; their government, and the improvement and government of existing streets, parks and parkways.

Under this plan the city council serves notice by resolution of intention to improve, in this instance by paving. The city engineer presents a plan and survey of the improvement showing its character and extent and giving the name of the owner of each parcel of land affected. This report if adopted by the council is filed with the city clerk.

The council then appoints five commissioners to view the premises, ascertain and award the amount of damages and assess the expense of the improvement upon the properties benefited. After hearings the commissioner's report and the objections to it are presented to the council committee originating the improvement, which considers them and within ten days files its report with the city clerk; this report is published once a week for two weeks before the city council can confirm it.

At the time of appointing commissioners, the city council may require that a certain percentage not exceeding one-third of the total cost of the improvement may be payable out of the city's general funds. Any taxpayer may appeal to the courts for relief from an assessment or award.

Other steps are: The board

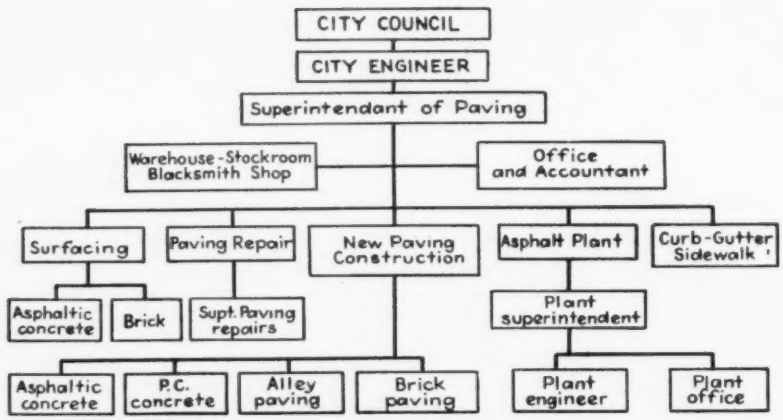


FIG. 2—STREET PAVING organization built up during 35 years of day-labor construction in Minneapolis.

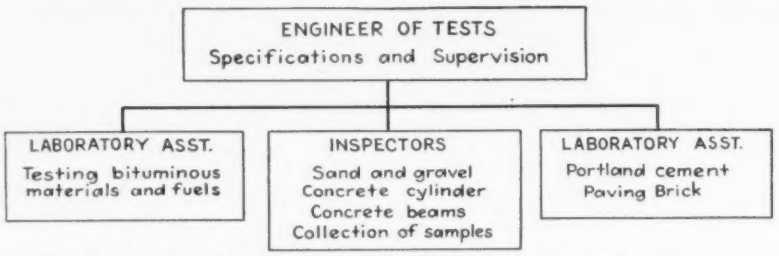


FIG. 3—LABORATORY CONTROL of all materials for Minneapolis street work is fully organized.

TABLE I—MAIN ITEMS OF CURRENT EQUIPMENT FOR PAVEMENT CONSTRUCTION IN MINNEAPOLIS

Grading
- 2 1-yd. shovel
- 1 ¼-yd. shovel
- 1 ⅜-yd. shovel
- Blade graders and tractors

Concrete Paving
- 2 27E pavers
- 1 Finishing machine
- 1 Permanent proportioning plant
- 1 Portable proportioning plant
- 1 Portable crane and 1 cu.yd. bucket
- Steel forms

Asphaltic Concrete
- 1 Black top paver
- 1 10-ton 3-wheel roller
- 1 12-ton 3-wheel roller auxiliary
- 2 12-ton 3-wheel rollers
- 1 10-ton tandem roller
- 1 Surface heater
- 1 10-ton tandem steam roller
- 1 8-ton tandem steam roller
- 1 1500 gal. power flusher
- Street kettles

Curb and Gutter
- 1 14S mixer
- 2 10S mixers
- 2 Aggregate scales

Brick Paving
- 1 5-ton tandem roller
- 2 3-ton rollers

Alley Paving
- 1 21E mixer
- 3 Loaders
- Forms

Motor Trucks
- 31 5-ton trucks (dump type)
- 38 1½-ton trucks (dump type)

Miscellaneous
- Mud jack
- Air compressor
- Pavement breakers
- Distribution tanks

of estimate and taxation must approve or reject the project within 30 days of confirmation by the city council; the city comptroller must designate funds out of which the project may be financed prior to the sale of Elwell bonds, and the city council must order the city engineer to proceed with the work. Payments may extend five, ten, fifteen or twenty years as designated, with interest at the rate shown on the bonds. About 90 days is the shortest time in which an Elwell proceeding may be inaugurated and completed ready for the work to proceed.

With the financing provided, the work comes into the hands of the paving department organized as shown by the chart Fig. 2. This organization has been built up gradually over a long period of years. Foremen and others in supervisory positions have been selected for their particular job because of their training and experience. The civil service system of classifying skilled workmen and supervisors insures preservation of the organization from year to year. Moreover all labor involved in the construction projects under the Five-Year law and Elwell law, where the financing is done in whole by the city council, is taken from the civil service list of the city of Minneapolis, and is subject to working hours and rate of pay set up by the council. Supervisory, administrative and highly-skilled positions in the classified service are filled by competitive examinations. Laborers are taken from an eligibility list according to their seniority. From time to time promotional examinations are held to advance those in the unclassified list to the classified service.

Equipment and plant

Like most cities Minneapolis has several types of pavement. This calls for variety of equipment as well as a variety of skilled workers, and a selected list of equipment has been assembled during the years. How the main items now stand is shown by the accompanying tabulation.

Equipment is purchased by the equipment division of the city engineer's department and is rented to the paving department on an hourly or daily basis; rental rates are determined by the original cost, cost of operation, depreciation and maintenance. The equipment division is responsible for the maintenance of the equipment in first-class condition throughout the paving season. At the close of the season, the machinery is returned to the division's shops where it is thoroughly checked, reconditioned and painted for the next season's paving operations.

Fixed plant in addition to the portable equipment consists chiefly of a concrete proportioning plant and plants for producing asphalt paving mixtures. Only the asphalt plants have any details different from the ordinary and they alone are described.

The asphalt plants do not come under the jurisdiction of the equipment division but are owned, operated and maintained by the paving department. There are two, one having a rated capacity of 600 tons of mixed material per 8-hr. day, and a smaller one with a capacity of 300 tons per 8-hr. day. Under ordinary conditions the average daily output of the two plants combined is between 700 and 900 tons; the output for a paving season is from 60,000 tons to 90,000 tons. These plants supply various types of mix for different classes of work: binder and wearing course for asphaltic concrete pavement; Topeka mix for repairs and resurfacing work; a street mix for repairing oiled streets and, bituminized-sand cushion for brick paving.

The large plant is a compact unit of recent design built by the Simplicity Systems Co. Aggregates are introduced by an automatic feeder, and are dried and heated by a 600-hp. oil burner. Accurate control of temperature is maintained by automatic heat regulators, and a recording pyrometer

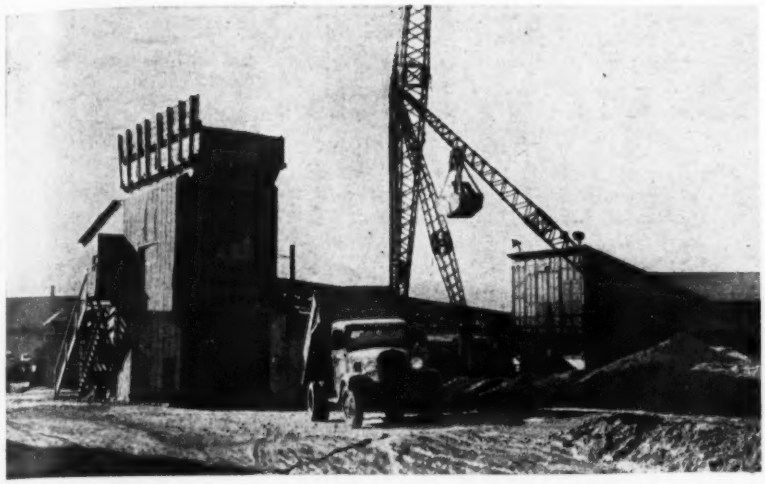


FIG. 4—**CONCRETE** for street paving in Minneapolis is proportioned and batched in the yard plant illustrated; field batching plants are also used.

gives a continuous temperature record. This system of heat control assures uniformity in the temperature of mixed material which is of prime importance in asphalt paving.

Materials are supplied to the plant by an electric stiff-leg derrick and clamshell. Automatic signal lights indicating the level of the aggregates in the storage bins guide the clamshell operator in feeding materials to the plant. The mixer is of 4,000-lb. capacity, twin-pug type, independently driven by a 75-hp. electric motor. The weigh-boxes and the mixer are entirely enclosed; suitable lights are provided to guide the mixer operator in the proper sequence of operations; a timing device insures accurate mixing time, and an enclosed screw conveyor and elevator carry filler dust to a separate storage bin. Having everything enclosed minimizes the dust nuisance in the mixing room.

The smaller plant consists of two units, the dryer and the mixing tower with the necessary elevators and feeding equipment. The dryer is internally fired by an oil burner. Steam is supplied from the boiler of the large plant. The function of the smaller plant is primarily to produce binder-course material.

Two hot-well type asphalt storage tanks of 60,000- and 70,000-gal. capacity provide ample storage facilities and allow the use of two grades of asphalt cement when so desired. Additional storage consists of a 30,000-gal. tank for fuel oil, a 20,000-gal. tank for cut-back asphalt and a 20,000-gal. tank for emulsified asphalt.

A plant-operation fund provides working capital for the asphalt plants. Asphalt materials used by the paving department are delivered from and charged for by the asphalt plant. The price per ton for mixed products such as asphaltic concrete is arrived at by taking into consideration all costs and charges involved in the operation, maintenance and amortization of the plant. A cost-accounting system at the asphalt plant office balanced twice a month furnishes accurate costs. The following tabulation shows items involved in computing the cost per ton. The percentages shown in the accompanying table indicate the proportion of each item of expense for the year 1935.

TABLE II—PROPORTIONATE EXPENSE FOR 1935

	Per cent
Plant investment (Bonds, sold, retired and interest)	1.61
Depreciation (Yearly tonnage basis)	8.85
Operation (Labor, materials, light, water and electricity)	13.20
Maintenance (Labor and materials)	5.55
Manufacturing stores (Materials used in batches)	65.51
Laboratory charges	1.74
Paving warehouse charges	.39
Administration (Office and clerical help)	3.15
Total	100.00

The charges made at the asphalt plant are billed to the proper project by the city comptroller. The comptroller issues monthly statements showing in detail all charges and credits to the plant operating fund. During the year's paving season in 1936, 89,471 tons of asphaltic-mixed material were manufactured at the plant.

Laboratory control

The city engineering department maintains an up-to-date laboratory at the asphalt plant for inspecting and testing the materials used in construction. This laboratory is one of the most important units of the paving department. Its organization plan is shown by Fig. 3. The work falls into four general divisions:

1. Drawing up specifications for all construction materials.
2. Inspection and testing of materials to be used.
3. Design and control of asphaltic-concrete and portland-cement-concrete mixtures.
4. Experimental and research work.

Comprehensive records are kept of materials used in construction so that past experience can serve as a guide in formulating and writing improved specifications. The laboratory is equipped with the latest approved testing apparatus and tests are made in accordance with A.S.T.M. standards. Close contact is kept with the work in the field and difficulties arising are promptly checked and corrected.

Merits of day labor

Paving under the day-labor system has proved a success in Minneapolis from the standpoint of economy and of quality of work done. It is believed that the following factors have contributed to the success of the system:

1. Efficient organization with skilled and experienced men in key positions.
2. Civil service, which insures continuation of experienced crews.
3. The use of modern machinery and equipment.
4. Careful selection of construction materials.

Day-labor permits the paving department to make changes and experiments at any time. Advantage is taken of this opportunity frequently, and the laboratory cooperates in all the experimental work. Due to this policy, the standards of construction have kept pace with the latest improvements and practices. These are described in an article to be published next week.

Housing Conference Called At French Exposition

The International Federation for Housing and Town Planning, London, England, and the International Housing Association, Frankfurt, Germany, are arranging to hold a joint conference in Paris July 5-13, 1937 simultaneously with the International Union of Local Authorities and the International Institute of Administrative Science.

Excursions in the neighborhood of Paris and two simultaneous study tours are planned to enable delegates to study the progress in housing and town planning in Paris and other parts of France.

The three major subjects to be considered by the Congress will be: national and regional planning; the question of rents for the small dwelling and the financing of the small dwelling; and the relative merits of vertical and horizontal development of housing.

Information regarding the Congress may be obtained from G. L. Pepler, president of the International Federation, 25 Bedford Row, London, WCI.

Homes on Wheels Create New Community Problems

RECOGNIZING the importance of the house-trailer in American life and citing estimates that by the end of 1937 there may be 1,250,000 persons calling 400,000 trailers "home," four national governmental associations have made a joint study of the administrative problems resulting therefrom. The report, entitled "The House Trailer: Its Effect on State and Local Government," has been released by the Chicago headquarters of the American Municipal Association.

The extent to which the American populace is taking to the road in permanent homes on wheels is indicated by the fact that in the eight months from March 1 to Nov. 1, 1936, the state of Virginia licensed 5,678 house-trailers, more than twelve times as many as were licensed during 1926 and twice as many as in 1935. Crop pickers, waiters and other seasonal employees, and traveling business men, are reported using the trailer as a permanent home in increasing numbers.

Many American cities and towns, as well as the states, have suddenly awakened to the fact that they have a trailer problem, and that the problem has many angles, says the report. City plan commissions, for instance, must determine where to locate trailers and how many to provide for, because zoning regulations must be met and ordinances amended in some cases to meet new conditions which trailers have created. The local fire laws, health regulations, police and traffic codes have much to say about trailers and are being studied and changed in many states and their subdivisions. Trailers are not fireproof and, when gathered in numbers on a limited area, are a definite fire menace. Health departments are concerned with groups of people in small living quarters whose methods of waste-disposal can have a detrimental effect on the community.

Although the trailerites have not yet created a welfare and public assistance problem, the question of legal responsibility will arise with more and more frequency as the trailer migrants encounter ill-health, financial embarrassment, expensive accidents, repairs and hospitalization. Schools will be called upon to educate trailer children suddenly thrust upon them by parents who have taken up local residence, from choice or from necessity, for financial or health reasons. Existing state housing codes will have to be invoked or amended, and some states will face the need to study housing standards and to provide effective statutes. Trailers present two tax problems: their effect on other taxable property, and their possibilities as a source of additional tax revenue.

At least seventeen states have enacted

Wide World Photo

THE TRAILER CAMP brings new problems to communities. Among other things, public officials must decide where they shall be located, how they should be regulated and what facilities must be provided for waste disposal, water supply and general sanitation

laws specifically regulating tourist camps. These laws, the report points out, may easily be brought up to date to cover trailers and trailer camps. State planning boards are advised to begin at once to survey the facilities available to trailers in each state. Analysis of 1,000 trailer camps shows that between two-thirds and three-fourths of them are located outside the corporate limits of cities and villages but near their borders. Thus the regulation of most trailer camps is at present primarily a county problem, and state regulations for trailers and trailer camps can be made to apply in county areas. Counties with zoning authority can use it for specifying the land to be used for trailers, the report adds.

New as they are, trailers have already caused municipal officials much concern in certain localities, according to the report. In Miami, Fla., for example, the influx of trailers has become so great and the establishment of camps so general that it has been found necessary to enact a special trailer ordinance. Ordinances have also been passed recently in Oakland, Long Beach, Banning, and San Diego, Calif.; St. Petersburg, Ft. Lauderdale and Clearwater, Fla., and Phoenix, Ariz. Helena, Mont., has established a city-controlled trailer camp.

Use of trailers as houses can be either encouraged or discouraged by municipal officials, the report points out. Establishment of a time limit for trailers in camps or elsewhere within the municipal limits, as has been done in a few cities, and strict enforcement of housing codes are discouragements. There is little doubt expressed, however, that if cities do not allow trailers to be occupied as permanent dwellings, those people desiring to make them so will simply move outside municipal limits into county areas where regulations are less stringent.

Though free to deal drastically with this new form of housing through direct application of existing health and housing standards, municipalities are urged to take advantage of the good points in the trailer movement.

The housing question

"Encouragement of the entire question of adequate housing standards would be the most fortunate result of public desire to use trailers as permanent dwellings," the report points out. "The most unfortunate results would be the enactment of statutes and ordinances sanctioning life in trailers under housing conditions which would not be allowed in standard dwellings."

On the matter of trailer taxation, the report says that "although it is too early to suggest what forms it should follow, it is assumed that trailers should be required to provide revenue to meet the additional financial burdens which they bring to states and localities, such as in highways and schools, utilities, fire and police protection."

Collaborating in the preparation of the report were H. G. Ogden and Arnold Miles, American Municipal Association; Paul P. Oppermann, American Society of Planning Officials; Louis E. Hosch, American Public Welfare Association, and Edmond H. Hoben, National Association of Housing Officials. The complete report may be obtained from the American Municipal Association, 850 East 58 St., Chicago, at 50 cents per copy.

Trailer Laws Sought in National Safety Drive

THE TRAILER, motorized home of increasing thousands of vacationists and gasoline nomads, now comes into its share of attention in the current national drive for highway safety. The house trailer is one of the most vexatious highway problems of today. Yet hitherto it has been considered more a question of regulation than of safety.

The trailer's highway aspects were recognized at the nine-state Regional Conference on Highway Safety in New York City, Mar. 12-13. The conference was called by Harold C. Ostertag, chairman of the New York Joint Committee on Interstate Cooperation which is affiliated with the Council of State Governments. A uniform legislative program to govern the trailer was officially considered there for the first time, and a uniform system of licensing and taxing the trailer was debated at length.

Legislative questions

The house trailer as a vehicle is only now finding real recognition in state statute books, and grave doubts have arisen as to whether certain phases of the motor vehicle laws applied to them. Since the trailer is mobile, the problem cuts across state lines, causing the current concern for uniform legislation on the trailer as a vehicle.

A recent report by the National Highway Users Conference shows that the trailer must be registered in forty-four states, but that it is taxed as personal property in only twenty-eight. Registration fees run from $2 annually in Connecticut to $10 per ton capacity in Colorado, and $10 minimum in Louisiana.

Non-resident privileges vary greatly, with twenty-five states on the reciprocity basis, and the others ranging from a twenty-five day privilege in Texas (with permit at 50c. granting an additional 120 days) to ninety-day privileges in Michigan, South Carolina and Wyoming.

Regulations on equipment, such as clearance lights and reflectors, vary widely. Some states require brakes on trailers if over certain weights. California, the District of Columbia, Oregon, Rhode Island, South Dakota, Texas, Utah, and Washington require brakes on the combination basis (that is, combinations must have brakes on one or more of the units adequate to stop within the distance specified).

The average maximum height for trailers by state law, the report shows, is about 12 ft.; the average "combination" length varies from 40 ft. in Alabama to 85 ft. in Washington. Most states fix the maximum width of the trailer at ninety-six inches.

Individual states have had to approach the trailer problem in different ways, in the light of special conditions, particularly such "vacation" states as California and Florida, and those in the north-central west. Michigan legislators must grapple the problem of regulating their trailers without crippling an industry which has had its greatest growth in that state.

As the trailer emerges into the safety scene, the national campaign for accident prevention through uniform traffic and drivers' license law waxes hotter.

Gate Contracts Awarded For Marshall Ford Dam

Award has been announced of contracts totaling $1,786,000 for the manufacture and delivery of 24 sets of 102-in. control gates and appurtenances for Marshall Ford Dam, under construction by the Bureau of Reclamation, on the Colorado River in Texas.

No bid was received for the manufacture of the whole lot by a single company. Of the proposals received by the Bureau of Reclamation Feb. 1, the lowest combination was submitted by the S. Morgan Smith Co. of York, Pa., the Bartlett Hardware Division of Koppers Co., Baltimore, Md. and the Hardie-Tynes Mfg. Co. of Birmingham, Ala., each of which was awarded a contract for the delivery of 8 sets of gates.

The S. Morgan Smith Co. will deliver 8 gates for $608,000; the Koppers Co. eight for $617,000; and the Hardie-Tynes Co. eight for $561,000.

The first of the gates must be delivered at Rutledge, Texas in 190 days and the last in 390 days. The contracts stipulate that the Walsh-Healey act must govern employment in the manufacture of the machinery.

The outlet works of Marshall Ford Dam will be located in 24 outlet conduits 102 in. in diameter arranged in 12 groups of two each in the base of the spillway section of the dam. A paradox gate will control each of the outlets.

CURRENT NOTES ON SEWAGE DISPOSAL

An analytical summary of recent developments conducted by

WILLEM RUDOLFS
Chief N. J. Sewage Experiment Station
New Brunswick, N. J.

● HOME SEWAGE DISPOSAL

The disposal of wastes from homes and small groups of houses by means of septic tanks and the necessary drainage piping is fairly well standardized in this country. This standardization does not necessarily mean that it is the best method or that there is no room for improvement. It is therefore of interest to call attention to an article by Girard (*La Technique Sanitaire et Municipale*, Aug., 1936) who describes a system, which he calls a "Bacterial nitrification plateau," that has been installed for isolated dwellings as well as for communities up to 1,000 inhabitants. The "plateau," located below the ground, consists of a simple concrete trough filled with stone, gravel or cinders, and covered with a concrete slab. In the soil on top of the trough and slab, vegetables or flowers are planted. Growth is luxurious, no odors are apparent, and there is no clogging of the tile or drainage system. The bacterial plateau can be used in connection with an ordinary septic tank if so desired. When installed for groups of houses the effluent is conveyed to a second trough or small tank and the surplus liquid is discharged into any nearby water course. Chemical and bacterial analyses show that the effluent from this reservoir is highly nitrified and conforms with the highest standards.

● GAS LIQUOR AND FILTERS

In cases where sedimentation is sufficient treatment for sewage the presence of gas liquor is of little importance, but when sewage requires oxidation treatment, difficulties are presented by the presence of crude or spent liquor containing large quantities of ammonia and a high biochemical oxygen demand. Large scale tests with trickling filters extending over five months, on the treatment of sewage containing both ammoniacal and spent gas liquor, by Key and Etheridge (*The Surveyor*, Nov. 20, 1936), showed the B.O.D. of effluents was slightly increased by the presence of 0.25 per cent spent liquor and somewhat more when the same volume of ammoniacal liquor was added. Despite the increased amount of ammonia fed to the beds the effluents showed that nitrification was almost complete, the residual ammonia being only 4 per cent of the original. With additions of 0.5 per cent liquor the effect on the filters was more pronounced, increasing the B.O.D. of the effluents considerably. It appears that moderate quantities of gas liquor affect the B.O.D. only when purification capacity of the filters is sufficient to produce a completely nitrified effluent with sewage alone.

● SULPHUR WASTE AFFECTS DIGESTION

Unknown and irregular discharges of trade wastes may affect scum formation on settling tanks, cause scum or foam or aeration devices and even interfere with digestion processes. Lashmar (*The Surveyor*, Oct. 16, 1936) reports that three trade wastes (from a paper mill, insecticide works and preserve factory) were discharged into the sewers of Sittingbourne containing sugar, china clay, glue, arsenic, lead, copper and sulphur in unknown quantities. These materials affected the proper working of settling tanks, and as a result the digestion tanks were deprived of necessary and regular quantities of fresh sludge. This in turn affected gas production so that at times it dropped to nearly zero. Fluctuations of gas production over a two year period varied from 1.47 to 0.338 cu.ft. per capita with an average of 0.862. Analyses of samples of sewage justified the conclusion that the sulphur wastes coming from the insecticide factory were the main cause of the difficulties.

In discussion it was suggested (*The Surveyor*, Oct. 23, 1936) that when certain trade wastes are added to sewage treated in an activated sludge plant the waste affects the resulting sludge which, when mixed with settled fresh solids, has an inhibitory effect upon digestion of the mixture. It appears that this result may occur although the mixing of the same trade wastes with the sewage would not hinder sludge digestion if the activated sludge had not been returned. There would be two possibilities causing such a reduction in gas production: (1) The poisonous substances would be fixed by the aeration process and retained in the activated sludge, whereas without aeration these materials would pass out with the effluent, or (2) when the activated sludge process is upset by the trade waste a large proportion of the sludge is discharged over the weirs of the final settling tank, so that the volume added to the digestion tank is less with subsequent reduction in gas production. Both factors may play a role of some importance.

● RISING OF SLUDGE

On occasion it is found that after initial settling activated sludge rises to the tank surface and passes out with the effluent. This blanket rising has been attributed by O'Shaughnessy to the reduction of nitrites to nitrogen gas, which upon liberation carried the sludge with it to the surface. Key and Etheridge (*The Surveyor*, Nov. 2 1936) have found that a similar reaction takes place between sludge and nitrates. They state that the two reactions completely explain the rising of the sludge to the surface. The reactions seem to occur between the nitrites and nitrates and some constituent of the sludge, but do not take place with the colloidal matter. The reactions have no effect on the ammonia content or B.O.D. of sewage alone. The gas produced is practically pure nitrogen and is approximately equivalent to 1½ times the nitrogen in the nitrite destroyed, while the amount of nitrate is equivalent to the nitrates with a smaller amount of nitrogen gas produced. The sludge can react only with a definite amount of nitrite and nitrate. Since such reactions would occur under more or less anaerobic conditions, it appears that the remedy would be to provide better or longer aeration.

● DIFFUSER PLATE CLOGGING

An important factor in the economics of the air diffusion system of activated sludge is the maintenance of high porosity of the diffuser plates employed, since the cost of air supply is to some extent governed by the pressure needed to provide uniform distribution over the whole of the plant and because irregular aeration is wasteful of air. A prolonged study of the causes of diffuser plate clogging at Manchester, England (Rivers Dept. *Annual Report* 1935–36), included among other things the effect of various fungoid growths found in the inlet carriers and on the surface of the plates. The investigation afforded no evidence that fungus growths are responsible to any sensible degree for diminishing the porosity of the plates but indications were that troubles for the most part are traceable to partial blockage of the surface pores by the entrance of sludge particles. Since clogging appeared to be due mainly to organic material, acid or alkali treatment may be considered sufficient for control purposes.

Economic Sizes of Pressure Conduits

By balancing pipe investment against capitalized cost of friction loss the most economical size adjustment is determined . . . Convenient graphical methods may be used.

By Julian Hinds

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IN ANY hydraulic pressure line the head usually varies from point to point along the line. To build such a pipe uniform in diameter is found to be wasteful, even though the shell thickness at each point is adjusted to the pressure. As the author shows, the most efficient size may be computed by utilizing the same principles as those developed for grade-line channels or aqueducts in his earlier paper, "Economic Water Conduit Size", ENR Jan. 28, 1937, p. 113. The present article together with the former one places in the hands of the hydraulic engineer a comprehensive, practical treatment of conduit or aqueduct proportioning. —EDITOR

PRESSURE CONDUIT DESIGN presents an economic problem rather different from that encountered in slope and size determination of open or grade-line channels. The same general principles are applicable as to channels (see *ENR* Jan. 28, 1937, p. 113), but the procedure differs because the hydrostatic head on the pipe affects its strength and cost.

The present article sets forth the methods of proportioning pressure lines. Together with the previous article it offers a complete statement of aqueduct economics. As in the case of open channels, the procedure was developed in the design of the Colorado River Aqueduct, whose 242-mile length includes many siphons and force mains.

If the head on an inverted siphon is low, so that the strength of the pipe is determined by practical minimum considerations rather than by the pressure, the pipe line is treated exactly as is a flow-line conduit except that the head lost in inlets, outlets, and bends and the cost of the end structures must be taken into account. These special items are important in short siphons, but may be neglected where the length is great.

But where the depth of the depression to be crossed by the pipe is such that the minimum thickness of shell or minimum reinforcement must be exceeded to give the required strength, the head becomes a cost variable. If the diameter of the pipe and its ability to withstand pressure can be varied continuously, a family of smooth cost-slope curves for selected heads may be plotted, as curves *A* and *B* of Fig. 1, and the economic slopes determined for the various heads by the same methods as those applied to various types of open conduit in the article above cited. The number of different sizes of pipe will depend on the number of head intervals for which cost curves are platted, a matter to be determined from practical considerations.

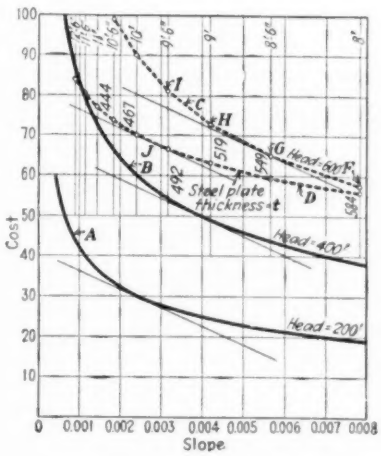


FIG. 1—COST CURVES for pressure lines may be drawn either for continuously varying diameter and head (A and B) or for fixed increments of diameter (C and D). The sloping line that represents value of head may be made tangent to any such curve.

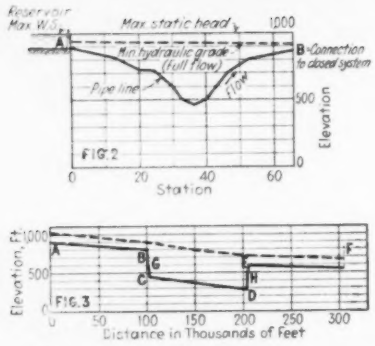
Pipe Sizes in Steps—Fractional pipe sizes may be avoided as illustrated by curve *C* of Fig. 1 where pipe diameters are assumed to change by 6-in. increments, so that the cost curve consists only of the points *F, G, H, I,* etc. The dotted connecting lines are meaningless. The best diameter is found at *G*, which corresponds to the lowest position of the slope tangent. Either *H* or *F* might be used without appreciable error, and no great advantage would be secured by the introduction of 2-in. or 3-in. intervals in diameter. Fig. 1 is to scale for a particular set of conditions.

Shell Strength in Steps—If the strength of pipe as well as the diameter changes in steps, due to even-inch spacing of reinforcement bars or commercial thicknesses of steel plates, a further variable is introduced. Such a case is illustrated by curve *D*, Fig. 1, which is to scale for a fixed thickness of steel plate. The numbers at the intersection of the curve with the pipe diameter lines represent the heads for which the various sizes are adequate.

The tangent point *J* corresponds to an allowable head of about 480 ft. and marks the economic slope for a pipe of the given strength, for heads up to that value. If a higher head is required, either a smaller diameter must be chosen (regardless of economics) or a thicker plate must be used. Usually there will be a family of curves similar to D, representing a series of plate thicknesses; and the slope-tangent (really slope-secant) is moved upward until it encounters the first size-thickness combination adequate for the required head. This process will be illustrated in subsequent examples.

Variation of size with head

It is well known that in a siphon crossing a deep depression for greatest economy, the diameter should vary with the head. The determination of the relation of diameter to head, for a specific problem, will be illustrated by selecting the economic sizes for a steel pipe line of 750 sec.-ft. capacity on the profile of Fig. 2. A hydraulic grade of at least 900 ft. is required at *B* to meet delivery conditions at that point. The water level in the reservoir at *A* cannot exceed 1,000 ft. Any storage lost by raising the minimum hydraulic gradient above the bottom of the reservoir must be replaced by storage elsewhere, at a cost which will be assumed to be $12,000 per foot of depth lost at *A*. The value of a foot of head at *A* is accordingly $12,000. The system below *B* is subject to being closed without closing the inlet to the pipe, thus raising the static level to El. 1,000 throughout the line. It is specified that



FIGS. 2 AND 3—STEEL SIPHON profile (above) analyzed for pipe sizes and thicknesses in Fig. 4. Below, a long ungated siphon in which length effect becomes a factor. Economic proportions are indicated by triangles in Fig. 4.

no plate shall be less than $\frac{5}{8}$-in. in thickness. The cost-slope relations are as shown on Fig. 4.

As a first step on Fig. 4, lay off the downward-sloping straight line *AB*, making its slope tan θ equal to $12,000, the value of a foot of head. Then apply this slope to the $\frac{5}{8}$-in. plate curve and find the point of tangency *C*. This marks the most economic size of pipe for carrying a 750 sec.-ft. flow under the conditions of the problem. The corresponding diameter is 140 in., and the permissible head is 277.7 ft. This is the theoretically correct pipe size to use for those parts of the line for which such a head is sufficient, but proceeding along the profile we eventually encounter greater heads.

The required additional strength could be secured by increasing the plate thickness with the same diameter, as at *D*, but a tangent through *D* parallel to *AB* will lie above many pipe sizes on the $\frac{5}{8}$-in. curve that are adequate for heads in excess of 277.7 ft. and are more economical than that corresponding to point *D*.

The apparent procedure is to consider the slope lines (parallel to *AB*) as secants rather than tangents, and move to the right along the $\frac{5}{8}$-in. curve, using each standard diameter for such distance as its strength permits, and proceeding until a point *E* is reached where a slope-tangent line reveals that a more economical selection can be made on the curve above, at *F*. Instead of using the diameter at *E* take that at *F*, move to the right again until economy indicates a change to the next plate thickness, and proceed in the same manner until the maximum head is reached.

Design by head curves

This procedure is theoretically correct, but results in pipe sizes which change up and down in an impracticable manner. This may be avoided by abandoning arbitrary pipe diameters and designing according to the head lines, even though this should lead to fractional or intermediate pipe diameters. To do this, apply the slope tangent to the various head lines, locating the points of tangency as at *G*, *J*, and *K*, and connect these points by a line. This line connects economic sizes for n = $12,000 and is not necessarily straight. To select the economic sizes, begin at *C*, as before; proceed along the minimum plate thickness line to *H* and then up the line *GK*, using the fractional pipe sizes as found at *H*, *I*, *L*, etc.

However, as little advantage is gained by following the line *GK* precisely, standard pipe sizes may if desired be preserved by simply choosing that diameter on each thickness line which comes closest to *H*, *I*, *L*, etc. The procedure is illustrated by the solid circles in Fig. 4. The maximum head of 541 ft. required for the siphon of Fig. 2 is reached with a pipe of 118-in. diameter made of $1\frac{3}{32}$-in. plate. The outfall end of the pipe comes back along the same marked points. The data thus made available are transferred to the profile of Fig. 2 by a simple arithmetical procedure, as illustrated in the partial set of computations, Table I.

The theoretical sizes and lengths shown in the table must be adjusted arbitrarily to give a practical arrangement. For example, the 26.7-ft. length of 138-in. pipe would be adjusted to the nearest full number of plate courses, or might be omitted altogether, in the interest of simplified construction. Similar adjustments would apply to the other sizes, many of which might profitably be omitted. Such frequent changes in diameter would evidently be impracticable for concrete pipe, because of the cost of forms.

Length effect in long lines

If flow from the end of the pipe in Fig. 2 is unrestricted, the economic size will vary with distance from inlet, as well as with the head. If a length of pipe near the downstream end of a high-head line, without valves or other restrictions to flow, is reduced in size so as to require an extra foot of fall, the outlet hydraulic elevation remaining unchanged, it is necessary not only to lift the water an additional foot at the inlet, but also to strengthen the entire line to carry the additional pressure. Accordingly, the cost of providing friction head increases along a pressure line.

This effect may be illustrated by an analysis of the example of Fig. 3, which is an extremely artificial set-up for a long steel pipe carrying a flow of 750 sec.-ft. and having the cost-slope relations of Fig. 4. A foot of head at the inlet is assumed to cost $10,000, and $\frac{5}{8}$-in. is again taken as the limiting plate thickness. For convenience, the value of a foot of head, or tan θ, will be referred to as *N*, and in this example will be variable.

Lay off on Fig. 4 a line similar to *AB*, but with slope 10,000. A tangent parallel to this line touches the $\frac{5}{8}$-in. thickness curve at 136-in. diameter, which is the economic size of pipe for the low-head line *AB*. This point is designated on Fig. 4 by a triangle, as are all other points used in connection with this problem. The allowable head is

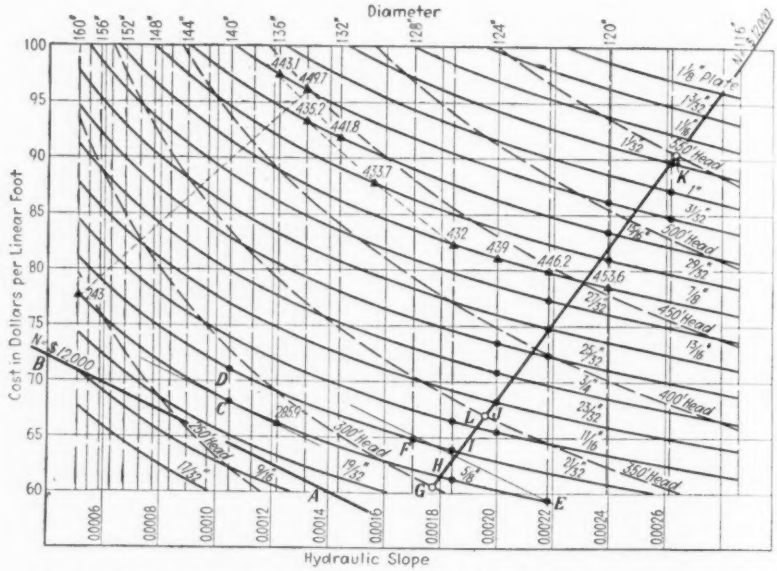


FIG. 4—COST CURVES FOR STEEL SIPHONS for both fixed thickness and fixed head, used in proportioning the siphons of Figs. 2 and 3.

TABLE I — ECONOMIC PIPE SIZES FOR THE SIPHON OF FIG. 2
Maximum pressure height constant at 1000 ft.

Pipe Dia., in.	Plate Thickness, in.	Allowable Head, ft.	Head Interval, ft.	Pipe Elev., ft.	Pipe Slope	Pipe Length, ft.	Total Length, ft.
		177.7		900.0			0
140	5/8	277.7	4.0	722.3	0.095	1870.5	1870.5
138	5/8	281.7	4.2	718.3	0.15	26.7	1897.2
136	5/8	285.9	4.2	714.1	0.15	28.0	1925.2
134	5/8	290.1	4.4	709.9	0.01	28.0	1953.2
132	5/8	294.5	4.6	705.5	0.07	440.0	2393.2
130	5/8	299.1	4.6	700.9	0.15	65.7	2458.9
128	5/8	303.7	4.9	696.3	0.15	30.7	2489.6
126	5/8	308.6	15.4	691.4	0.15	32.7	2522.3
126	21/32	324.0	15.4	676.0	0.15	102.7	2625.0
126	11/16	339.4	5.4	660.6	0.30	102.7	2727.7
124	11/16	344.8				36.0	

..... etc., with results as follows.....

Pipe Dia., in.	Plate Thickness, in.	Length, ft.	Pipe Dia., in.	Plate Thickness, in.	Length, ft.	Pipe Dia., in.	Plate Thickness, in.	Length, ft.
124	23/32	52.7	118	1-1/32	110.0	124	3/4	52.0
124	3/4	52.0	118	1-1/32	110.0	124	23/32	52.7
124	25/32	52.3	118	1	110.0	124	11/16	18.0
122	25/32	21.7	118	31/32	56.7	126	11/16	51.3
122	13/16	53.0	120	31/32	108.0	126	21/32	51.3
122	27/32	53.0	120	15/16	54.0	126	5/8	16.3
122	7/8	53.3	120	29/32	54.0	128	5/8	15.3
120	7/8	24.7	120	7/8	24.7	130	5/8	15.3
120	29/32	54.0	122	7/8	53.3	132	5/8	14.7
120	15/16	54.0	122	27/36	53.0	134	5/8	28.0
120	31/22	108.0	122	13/16	53.0	136	5/8	28.0
118	31/32	56.7	122	25/32	21.7	138	5/8	26.7
118	1	110.0	124	25/32	52.3	140	5/8	1855.5
						Total.....		6594.9

Note.— Many lengths shown are impracticably short. Alter theoretical length to get *practical* length.

285.9 ft., which is in excess of the required head; hence, adding a foot of head adds nothing to the cost of this part of the line and N remains constant at $10,000.

But at some point between B and C in Fig. 3 the head begins to control the thickness, and the value of providing additional friction head begins to increase. The cost of adding a foot of head to any pipe size may be found by dividing the difference in cost for two adjacent points in Fig. 4 by the corresponding head interval. The fractional plate thicknesses thus assumed are not available, but with an increase in head substantially equivalent results are secured by a rearrangement of sizes. For the sizes required for Fig. 3, the cost of increasing the head one foot varies between $0.15 and $0.20 per foot of pipe.

The computations which accompany the selection of economic sizes for the profile of Fig. 3 are illustrated in Table II. The fall required for the 136-in. line from A to B is computed, to give the hydraulic elevation and required head at B; then the distance BG on the steep section BC for which the same pipe may be used is computed. In the length GC, a series of diminishing diameters with $\frac{5}{8}$-in. plate might be chosen, as in the sloping inlet of Fig. 2, but the sections of the various sizes would be impracticably short; therefore the size required at C may be used throughout. The required head at C (Table II) is 451.4 ft. Moving the N = $10,000 line up the diagram, Fig. 4, a 120-in. pipe with $\frac{7}{8}$-in. plate thickness is found to be the first that will carry this pressure; hence, this size may be used for GC in Fig. 3, as well as for such portion of the valley section CD as may be appropriate.

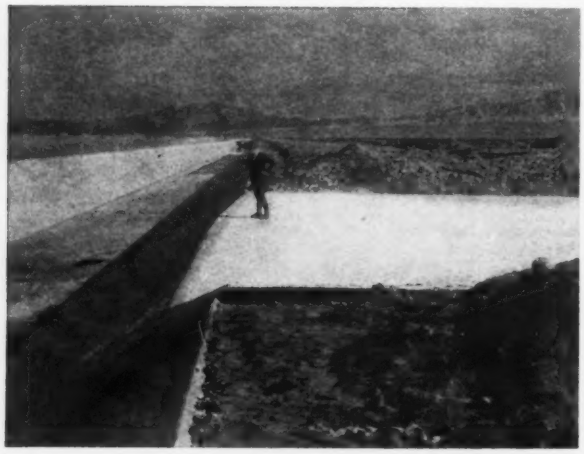
As shown in the table, GC has a length of 166 ft. The cost data from which Fig. 4 was prepared show that increasing the pressure head a foot increases the cost of a foot of this size pipe $0.154, this value being entered in the table as ΔC. The value of a foot of head will be increased in the length GC by $0.154 \times 166 = \$26$, which is insignificant, but is nevertheless entered in the table as ΔN. The value of a foot of head at C thus becomes N = $10,026, and the slope tangent line is reset to this value.

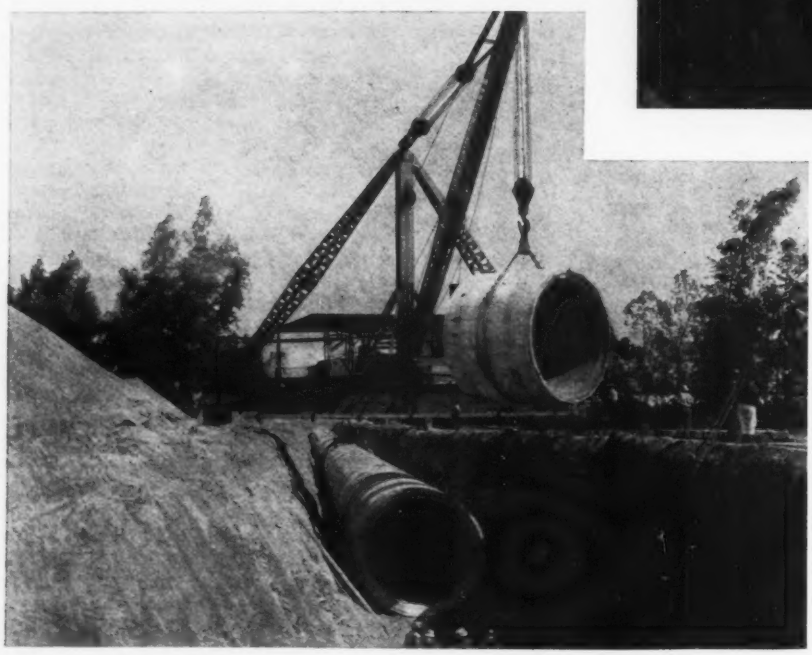
Head value increases

The friction slope for a 120-in. pipe is greater than the ground slope between C and D; hence, as long as this size is used the pressure head will decrease. Using N = $10,026, the next economic size is found to be 122-in. with $\frac{7}{8}$-in. plate and an allowable head

TABLE II — VARIABLE PIPE SIZES FOR THE SIPHON OF FIG. 4

Point	Distance, ft.	Accum. Dist., ft.	Pipe Slope	Friction Slope	Pipe Dia., in.	Plate Thickness, in.	Pipe Elev., ft.	Hydr. Elev., ft.	Required Head, ft.	Allowable Head, ft.	ΔC	ΔN	N	Cost per lin. ft.	Total Cost,
A		0					900.00	1,018.02	122.0				$10,000		
	100,000									285.9				$66.10	$6,610,000
B		100,000	.00100	.00122	136	5/8	800.00	896.02	96.02				10,000		
	190									285.9				66.10	12,559
G		100,190	−Vertical	.00122	136	5/8	610.12	895.79	285.67				10,000		
	166									453.6	$0.154	$ 26		78.46	13,024
C		100,356	−Vertical	.00239	120	7/8	444.00	895.39	451.39				10,026		
	8,238									453.6	.154	1,269		78.46	646,353
		108,594	.00176	.00239	120	7/8	429.50	875.70	446.2				11,295		
	17,143									446.2	.157	2,691		79.76	1,367,326
		125,737	.00176	.00218	122	7/8	399.33	838.33	439.0				13,986		
	29,167									439.0	.164	4,783		81.06	2,364,277
		154,904	.00176	.00200	124	7/8	348.00	780.00	432.0				18,769		
	0									432.0	.170				
		154,904	.00176	.00184	126	7/8	348.00	780.00	432.0						
	8,500									433.7	.183	1,556		87.63	744,855
		165,404	.00176	.00156	130	29/32	333.04	766.74	433.7				20,325		
	3,409									435.2	.193	658		93.21	317,753
		166,813	.00176	.00132	134	15/16	327.04	762.24	435.2				20,983		
	20,625									441.8	.190	3,919		91.79	1,893,169
		187,438	.00176	.00144	132	15/16	290.74	732.54	441.8				24,902		
	2,407									443.1	.201	484		97.43	234,514
		189,845	.00176	.00122	136	31/32	286.50	729.60	443.1				25,386		
	15,000									449.7	.193	2,895		96.01	1,440,150
D		204,845	.00176	.00132	134	31/32	260.10	709.80	449.7				28,281		
	207									449.7	.193	40		96.01	19,874
H		205,052	+Vertical	.00132	134	31/32	467.10	709.53	242.43				28,321		
	120									243.0				77.70	9,324
E		205,172	+Vertical	.00051	160	5/8	587.10	709.47	122.37				28,321		
	100,000									243.0				77.70	7,770,000
F		305,172	.0005	.00051	160	5/8	537.10	658.47	121.37				28,321		
													Total cost.....		$23,443,178





THESE COLORADO RIVER AQUEDUCT structures were built from economic designs based on balancing first cost and operating cost. The top views are a canal and siphon on the main aqueduct; that below is construction of a distribution conduit.

of 446.2 ft. Friction in the 120-in. pipe will reduce the head to this amount in a distance of 8,238 ft., which is the length of 120-in. by $\frac{7}{8}$-in. pipe required. The corresponding value of ΔN is $1,269, bringing N up to a total of $11,295. Using this value for the new cost-line slope, the next economic size is found to be 124-in. by $\frac{7}{8}$-in. thick, with an allowable head of 439.0 ft. A length of 17,143 ft. of the 122-in. line is required to reach this head, the corresponding value of ΔN being $2,691, bringing N up to $13,986. With this new cost-line slope the next economic pipe size is found to be 126x$\frac{7}{8}$, with an allowable head of 432.0 ft. A length of 29,167 ft. of 124-in. line is required to reach this head, the corresponding value of ΔN being $4,783, bringing N up to $18,769. Applying this new value to the point attained (126x$\frac{7}{8}$-in.) as a check, it is found that a 130-in. pipe of 29/32-in. plate is equally economical, and a little investigation shows that economy requires an increase in plate thickness at this point. Therefore, the 126x$\frac{7}{8}$-in. size is given a zero length, and choice of sizes proceeds from the 130x29/32-in. size, as shown by table.

It should be noted that from point G up to 154,904 ft. the friction head is in excess of the pipe slope and the required head is decreasing. With the 130-in. diameter or larger, the relation is reversed. The 124x$\frac{7}{8}$-in. size was used until the next weaker, and cheaper, size became adequate, but the 130x29/32-in. size will be used until it becomes necessary to change to a stronger and more expensive size. This occurs at distance 165,404, where the required head becomes 433.7 ft., which is equal to the strength of the pipe. The value of N at this point is $20,325.

Applying this value to the diagram, it is found that the most economical pipe, good for a head in excess of 433.7 ft., is 134x15/16-in., with an allowable head of 435.2 ft. Under ordinary circumstances this gain in strength would be too little to bother with, but under the rather unusual conditions of the present problem the new size may be used for a length of 3,409 ft. In this distance the value of N increases to $20,983. The next most economical size is 132x15/16-in., with an allowable head of 441.8 ft., which is good for a length of 20,625 ft.

This reversal of diameter-trend results from the before-mentioned reversal of head-trend. This trend is opposed by the increasing value of N, and the next most economical size for an N of $24,902 is 136x31/32-in., with an allowable head of 443.1 ft. This is good for 2,407 ft. of line, and brings the value of N up to $25,386. The next most economical size is 134x31/32-in., with an allowable head of 449.7 ft., which may be used for the remainder of the distance to point D, and then up to H. The line of progression is indicated in Fig. 4 by a dotted line. In practice, however, the irregularity in pipe sizes here would be eliminated by substituting 134-in. pipe of proper plate thickness for both the 132-in. and 136-in. theoretical sizes.

The value of N at point H is $28,321. The corresponding economic size of pipe for HE and EF is 160-in. with $\frac{3}{8}$-in. minimum thickness of plate.

Scope of length effect

The prinicipal purpose of this example is to show the great difference in diameter and hydraulic slope for the portions AB and EF. The entire line

is assumed to be of similar construction, to assist in making comparison, but the same relative difference in size and slope would occur if the two ends were composed of canals, tunnels, or a mixture of different type of flow line or low head conduits, separated by the long, high-head siphon *BCDE*. The increment to *N*, however, occurs only in the high-head portion of the line.

This length effect applies only to pipe lines without gates or other flow or pressure-regulating devices. The same effect occurs in any ungated high-head line regardless of length, but is negligible in a single short siphon. A multitude of short, high-head siphons produce the same effect as one long one, even though they may be separated by other types of conduit.

The total drop in hydraulic gradient from *A* to *F* in Fig. 3, is 359.55 ft. A uniform pipe line using this fall and conforming to the stated conditions would have some fractional diameter approximating 137 in., or about the same results could be secured by using 163,444 ft. of 136-in. pipe and 141,728 ft. of 138-in. pipe. Minimum thickness of plate can be used for the two ends, with increased thicknesses for *GCDH*.

The total estimated cost of such a line exceeds that of the variable line by $567,000, or about 2.4 per cent.

Colorado aqueduct sizes

Typical cross-sections of the tunnel, covered conduit, and canal sections used on the Colorado River Aqueduct between the intake and the Cajalco Reservoir are shown on Figs. 5, 6 and 7, and typical cost-slope curves are shown on Fig. 12.

Tunnels—There are 31 separate tunnels, varying in length from 338 ft. to 18.3 mi., with a combined total length of 92 mi. Rock conditions, accessibility and other factors vary widely; hence each tunnel has its individual cost-slope relation and its own economic slope or size. Curves were prepared for each tunnel, similar to that for the Coxcomb Mountain tunnel shown at (*a*) in Fig. 12, and economic sizes were found by the slope-tangent method with tan θ = $65,000. Except for the Bernasconi and Valverde tunnels, the economic sizes thus found varied from about 15 ft. 9 in. to about 16 ft. 3 in. It is evident from Fig. 12 that there is little difference in over-all economy within this range, and that the adoption of a standard size was desirable. A diameter of 16 ft. with a slope of 0.00065 was chosen. The Bernasconi and Valverde tunnels, which lie beyond the point of control at San Jacinto, are 15 ft. 3 in. in diameter.

Cut-and-Cover — The cut-and-cover conduit totals 55 mi. in length and is divided into many sections by intervening siphons and tunnels. Some of these sections are in rough terrain,

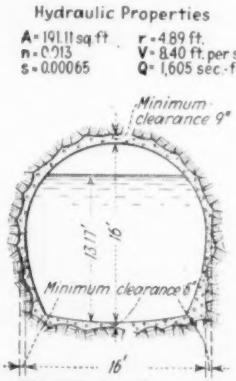


FIG. 5 - Typical Tunnel Cross Section

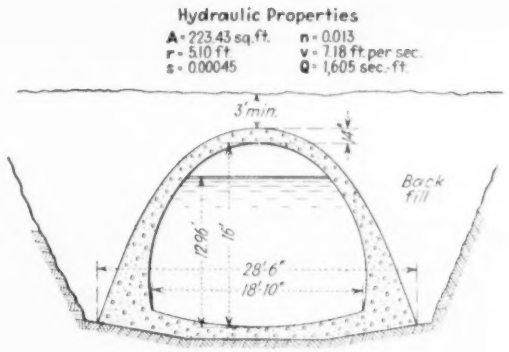


FIG. 6 - Grade Conduit

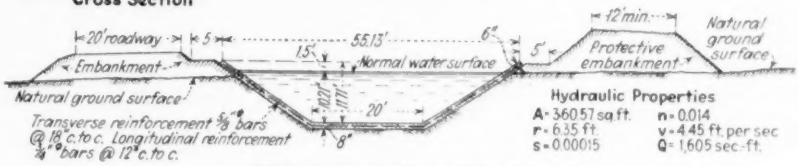
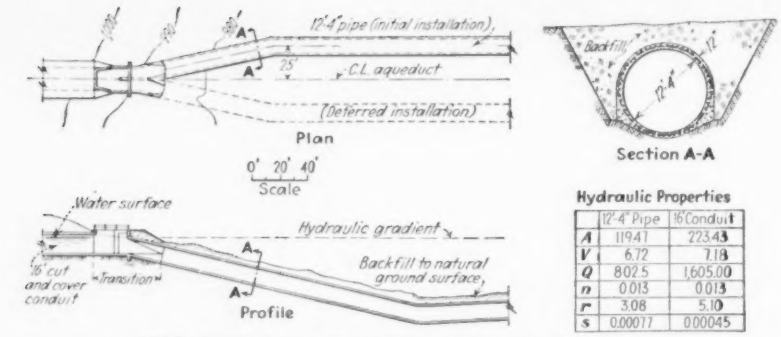


FIG. 7 - Cross Section of Lined Canal

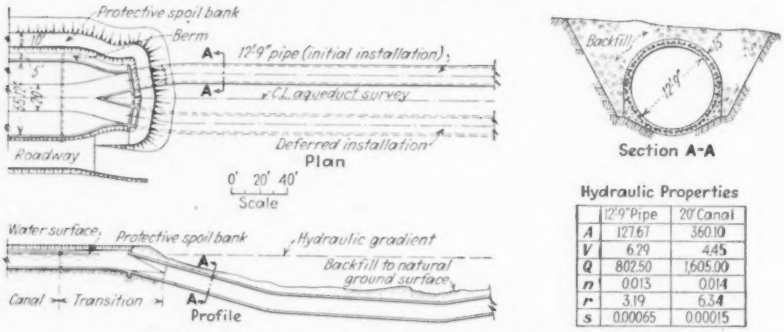
FIGS. 5–7—TUNNEL, CONDUIT AND CANAL sections typical for Colorado River Aqueduct. Their dimensions were selected by use of the cost curves of Fig. 12 in conjunction with consideration of field conditions.

CONDUIT OR PIPE constitutes a large part of the distribution network. Cost of forms limited that number of changes in size and wall thickness to less than the theoretical calculations indicated.



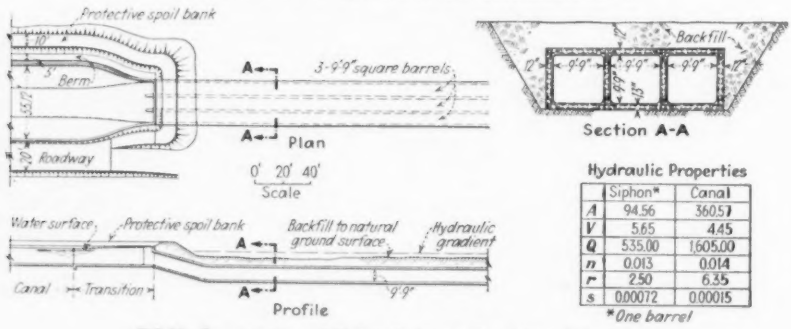
Hydraulic Properties		
	12'-4" Pipe	16' Conduit
A	119.41	223.43
V	6.72	7.18
Q	802.5	1,605.00
n	0.013	0.013
r	3.08	5.10
s	0.00077	0.00045

FIG. 8 - Double-Barrel Siphon Between Sections of Conduit



Hydraulic Properties		
	12'9" Pipe	20' Canal
A	127.67	360.10
V	6.29	4.45
Q	802.50	1,605.00
n	0.013	0.014
r	3.19	6.34
s	0.00065	0.00015

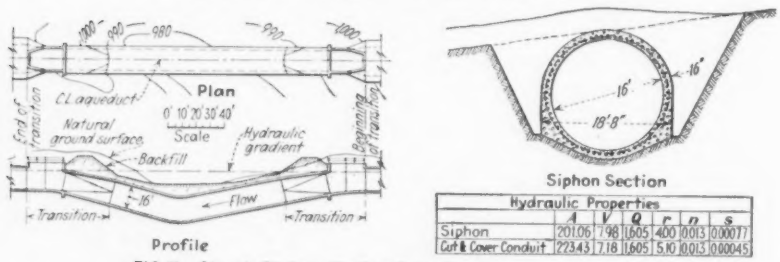
FIG. 9 - Double-Barrel Siphon Between Sections of Canal



Hydraulic Properties		
	Siphon*	Canal
A	94.56	360.57
V	5.65	4.45
Q	535.00	1,605.00
n	0.013	0.014
r	2.50	6.35
s	0.00072	0.00015

*One barrel

FIG. 10 - Square-Barrel Siphon Between Sections of Canal



Hydraulic Properties						
	A	V	Q	r	n	s
Siphon	201.06	7.98	1,605	4.00	0.013	0.00077
Cut & Cover Conduit	223.43	7.18	1,605	5.10	0.013	0.00045

FIG. 11 - Short Siphon Under Low Head

FIGS. 8-11—DIFFERENT FORMS OF SIPHON were found desirable on the Colorado River Aqueduct for structural reasons. All important siphons were made of two circular barrels (Figs. 8 and 9), while short siphons under low head are either triple square barrels or single circular barrels (Figs. 10 and 11)

with deep and difficult digging; others are in easy, smooth ground. Cost-slope curves were plotted for each distinct change in conditions. For the typical curve, (*b*) in Fig. 12, the economic slope is 0.0004, corresponding to a diameter of 16 ft. 4 in.; in the more difficult locations the economic size was smaller. A diameter of 16 ft. with a slope of 0.00045 was adopted as standard.

Canal Sections—Open lined canal was used only under favorable conditions and was more nearly constant in cost. A typical cost curve is shown at (*c*) in Fig. 12. A section having a base width of 20 ft. and a depth of 10.21 ft., on a slope of 0.00015, was adopted as standard. The true economic slope averaged less than this but did not provide sufficient velocity to keep the canal cleared of sand that may blow into it. The full-flow velocity for the section as designed is 4.45 ft. per sec.

Siphons—Cost-slope relations for siphons varied widely, due particularly to the variable local conditions and (because of variable lengths) to variations in the effect of transition losses and the cost of end structures. Individual studies resulted in a multitude of sizes, which were clearly undesirable and actually uneconomical because of complicated form requirements. For structural reasons all important siphons were made of two circular barrels. A single circular barrel and a triple square barrel were used for short low-head structures. Typical siphons are illustrated in Figs. 8, 9, 10 and 11.

Standard diameters adopted are: Double barrel between conduit sections, 12 ft. 4 in.; double barrel between canal sections, 12 ft. 9 in.; triple square barrel for low-head short siphons between canal sections, 9 ft. 9 in.; single barrel for low-head short siphons between cut-and-cover sections, 16 ft. The small theoretical increase in cost resulting from this limitation of sizes was more than offset by the interchangeability of forms and other benefits of standardization.

Distribution Feeders—The delivery lines out of Cajalco are all circular and operate under pressure. The "Upper Feeder" line (see map of system, *ENR* Jan. 28, 1937, p. 114), which has been completely designed and is now under construction, operates between fixed hydraulic elevations at the reservoir outlet, and the terminus in Eagle Rock Canyon. It was designed in accordance with the principles of Fig. 4, with additional variables due to decreasing discharge at points of diversion. The line leaves the reservoir in a precast concrete siphon of 11 ft. 8 in. diameter 2.3 mi. long, and then goes into a steel line 10 mi. long. The steel pipe varies from 11 ft. 6 in. to 9 ft. 8 in. in diameter, the latter size being used on a steel truss bridge across the Santa Ana River, where the maximum head is 464 ft. The value of a foot of head increases from $11,100 at the upstream end of the steel siphon to $19,800 at its downstream end.

The steel line is followed by 49.2 mi. of precast concrete pipe and circular pressure tunnel, varying from 11 ft. 8 in. to 9 ft. 8 in. in diameter and generally under low head. Diameter changes here are due principally to reduction of flow by diversions.

General considerations

The principles herein discussed must be used cautiously, particularly on

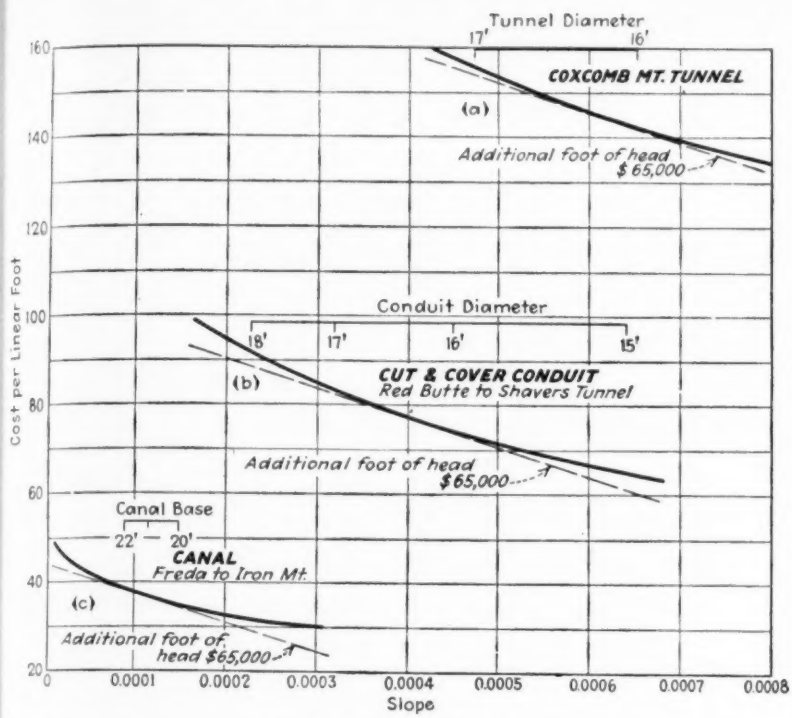


FIG. 12—COST CURVES FOR AQUEDUCT TYPES used in selection of basic dimensions. The value of an additional foot head was $65,000.

complicated projects involving so large a number of variables as was encountered on the Colorado River Aqueduct. The point of greatest ultimate economy is not always definitely marked. The point of tangency to a cost curve is indefinite; the exact form of the curve is also uncertain. There is an unavoidable confusion of present and future values which cannot be eliminated from the problem, however painstakingly the solution may be made. Because present necessities are more pressing than future needs, there is usually a tendency to lean toward a reduced first cost, at the risk of a reasonable increase in future operating expenses. If funds for construction are limited, it may be necessary to depart radically from economic design; but even in such case the principles herein developed are useful in establishing relative sizes.

Algebraic solutions may be substituted for graphical solutions, if desired, by merely writing equations for the cost curves instead of platting them. If there is only one conduit, the first derivative of the combined cost curve may be equated to zero to give the minimum point. The same result is secured if the first derivative of the first-cost curve is equated to the value of a foot of head. The economic points for different types of conduit may be located in this manner. An analytical solution is useful in many special cases, and is preferred by some computers for ordinary work. However, the average computer is likely to find the derivation of a comprehensive cost equation for even the simplest conduit more difficult than the construction of a cost curve. The exceptional computer will have no trouble translating the graphical solution to an analytical one in suitable cases.

The details of the foregoing method of analysis have been worked out largely by D. B. Gumensky, H. V. Crawshaw, F. S. Haines, and H. L. White, of the designing section of the Metropolitan Water District of Southern California, of which F. E. Weymouth is general manager and chief engineer.

Tax Limits On Real Estate Appraised

OVER-ALL TAX LIMITS on real estate, depression-born proposal again engaging the thoughts of many state legislatures this year, are weighed in the balance and found wanting in the pamphlet, *Tax Limits Appraised*, recently published by the Public Administration Service, Chicago, Ill. Authors are A. M. Hillhouse and R. B. Welch, research consultants respectively of the Municipal Finance Officers' Association of the United States and Canada and the National Association of Assessing Officers.

Presenting arguments both for and against, the pamphlet is directly addressed to the constitutional over-all tax limit which has been widely discussed. The over-all limit, in its strictest sense, is defined as "a constitutional or statutory provision fixing a maximum property tax rate or rates which may not be exceeded by the combined rates of the state and all its political subdivisions having jurisdiction within a given area."

At present, only nine states have what are generally called over-all tax limits, although the first state to pass such a law, Rhode Island, did so nearly sixty years ago. Five states adopted their limits during the depression years 1929 to 1936. These states are: Indiana, Michigan, New Mexico, Washington and West Virginia. Ohio and Oklahoma tightened their limits during this period, and Nevada transferred an over-all limit from the statute books to the constitution.

The first conclusion reached by the authors of the pamphlet, who base their findings upon experience-stories of eight of the nine tax-limit states, is that an over-all tax rate limit of the type advocated will result in a substantial immediate reduction in real estate taxes, but will not bring about important governmental economies or lasting reductions in total tax burdens. For each of seven states reductions are shown in the years following adoption of the tax limit, the total reductions now standing at over 100 million dollars a year. The loss in property taxes, the authors add, will eventually be made up by replacement revenues with additional costs incident to their administration. In the states with tax limits a retail sales or gross income tax has usually been adopted as the major replacement revenue. These cost the small home owner and the wage earner more than the savings realized in property taxes, they point out.

Figures quoted from present tax-limit states show that replacement revenues, while they have often equalled or even exceeded the decline in property tax levies attributed solely to over-all tax limits, have been considerably less in amount than the total decline in property tax levies.

Alternatives to the proposed over-all tax limit are suggested. One of them is the substitution of statutory over-all limits varying from one municipality to another. Better results would be obtained, however, the authors explain, if cities would follow sounder policies for financing capital improvements, would adhere more strictly to a pay-as-you-go policy in all periods except depressions, and if a general revision of the state tax structure could be brought about.

Wells for the Water of Hawaii

A new type of water development in basaltic rock formation on the volcanic island of Oahu permits skimming of artesian basins at sea level and thus eliminates danger of saltwater contamination

By Norah D. Stearns
Spreckelsville, Maui, Hawaii

OAHU is the third largest of the eight inhabited islands comprising the Territory of Hawaii. On it are located Honolulu, the U. S. Army Schofield Barracks and the Pearl Harbor Navy Yard.

Artesian groundwater supplies, principal source of water on the island, have been endangered by seawater invasion during drought periods. In this article Dr. Norah D. Stearns, formerly a member of the U. S. Geological Survey in Hawaii, describes a new type of well construction that is being used to minimize saltwater contamination and permit increased development of the artesian basins. —EDITOR.

ON THE ISLAND OF OAHU, Hawaii, where extensive use of drilled artesian wells has seriously lowered groundwater elevations in some places to a point where invasion by saltwater is a practical reality, a new type of well is being used which minimizes this danger yet permits increased withdrawals. Known as the Maui well, this method of water development utilizes the artesian basin supply but avoids salt contamination by skimming fresh water off the underlying layer of heavier seawater. It consists simply of an inclined shaft from the ground surface to the water table level where one or more infiltration tunnels are extended horizontally at the zone of saturation. Pumps are used to elevate the water from the tunnels to the surface.

At the present time six installations of this type are in use or being constructed—two are being operated by the Honolulu Board of Water Supply, two are under construction by the U. S. Army and Navy departments, another for a sugar plantation, and one for a rural supply in Honolulu County (Fig. 1). It is estimated that a total of 2,500 ft. of shaft and about 2,000 ft. of tunnel will be excavated to make available a water yield of 40 m.g.d. The cost of the six wells when fully equipped with delivery systems will be about $1,000,000.

Maui type of well

This new type of well was named and first recommended as a method of increasing the water supply of Honolulu by H. T. Stearns, geologist in charge of Hawaiian groundwater investigations for the U. S. Geological Survey. Wells operating on the same principle have been successfully employed on the Island of Maui for some 35 years, chiefly for supplying water to irrigate sugar cane.

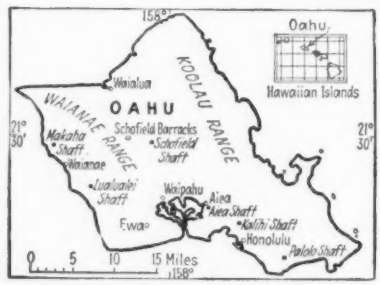


FIG. 1—LOCATION of the new well developments on the Hawaiian island of Oahu.

Speaking of this well, Dr. Stearns says, (*Bull.* No. 1, Div. of Hydrography, Territory of Hawaii), "The Maui type of well consists of either a vertical or an inclined shaft, driven a few feet below the water table, with one or more horizontal tunnels driven from the bottom of the shaft to skim fresh water from the upper part of the zone of saturation. Although it is not essential for the shaft to be in waterbearing rock, the tunnels are always driven into permeable basalt, the location of which is often predetermined by test holes. The most effective direction to drive these tunnels is generally at right angles to the strike and inland across the dip of the lavas. Where the zone of the fresh water is thick, as it is under most of Oahu, tunnels may be unnecessary. The pumping machinery is placed in a chamber at the bottom of the shaft, and the shaft is locally deepened to provide a sump for the suction pipes. The well is usually dug at the altitude from which the water is to be distributed, thereby saving pipe line. The shaft is either lined or unlined according to the character of the materials encountered, but the tunnels are not lined. A well of the Maui type encounters a much greater amount of pervious rock than a drilled well, but the essential differences is that the Maui type of well skims the fresh water from the top of the zone of saturation, whereas the drilled well passes through many feet of non-water-bearing rock and then must penetrate deep into the zone of saturation in order to have an effective yield. The drilled well therefore derives its supply from the lower part of the zone of fresh water rather than from the upper part (Fig. 3).

"With wells of the Maui type it is safe to lower the water level either to or a little below sea level, and because the aquifers are highly permeable the zone of influence is greatly extended. This lowering of head would decrease the natural discharge from the basin now occurring through overflow and upward percolation through the confining beds. Because of the low gradients of the water table this lowering of the head would greatly increase the flow into the pumped area. Thus water would flow into the Honolulu area from adjacent regions, so that the net result would be to increase the size of the recharge area.

"As it costs less to build a well of the Maui type than to drill a battery of artesian wells, the safe yield will likewise recover greater amounts of water safely in the areas being pumped by the plantations. In Honolulu the danger from salt is far greater in time of drought than in the other artesian areas because the draft from outside of Honolulu is not as great in proportion to the supply."

Honolulu's water supply

The story of Honolulu's artesian water supply begins with the drilling of artesian wells in 1879. Before that period shallow dug wells supplemented streams and natural springs as a supply for the then small city. A curious editorial note is found in the *Polynesian*, dated April 7, 1855, to the effect that one D. Quinlan will supply spring water to residents of Honolulu from a water cart at prices ranging from 50 cents to one dollar a week according to the quantity taken.

The first drilled well on the Island of Oahu was completed in 1879 at Honouliuli, a village west of Honolulu. It yielded flowing water. The next year flowing water was struck in Honolulu, in the Marques Well, at a depth of 273 ft. in basalt beneath soil, sand, coral and clay. At a depth of 295 ft. this 6-in.

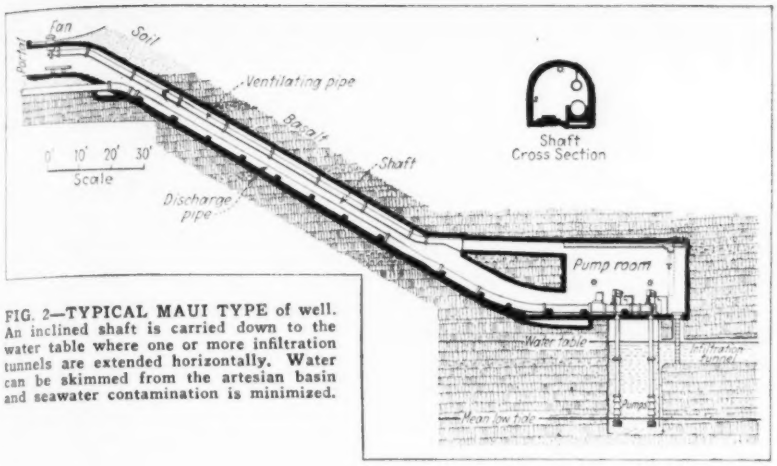


FIG. 2—TYPICAL MAUI TYPE of well. An inclined shaft is carried down to the water table where one or more infiltration tunnels are extended horizontally. Water can be skimmed from the artesian basin and seawater contamination is minimized.

well yielded 96,000 gallons a day. Its success gave such an impetus to drilled wells as a source of water supply that a total of 174 wells had been drilled in Honolulu by 1933, and about 700 on the Island of Oahu.

Theories regarding the geologic structure and the occurrence of water at Oahu were evolved early because it was found by experience that some of the drilled wells failed to obtain flowing water, some wells close together had to be drilled to considerably different depths to strike the aquifer, and some wells encountered saltwater only. The drillers soon recognized that wells had to be made much deeper if located at the mouth of a big valley than if seaward of an interstream ridge. Also, they soon found by experience that the sediments overlying the aquifer thickened seaward and that once flowing water was encountered production from a well could be increased by drilling deeper but that in so doing the salt content of the water increased.

Artesian structure

The geologic structure, the form of the cap rock and the saturated zone at Honolulu is shown in Fig. 4. In general the beds of basaltic lava which make up the main mass of Oahu dip gently seaward from the crests of the two mountain ranges. They are very permeable and are saturated with water, fresh water overlying salt water with an intermixed zone between. The seaward end of these lava beds at Honolulu in most places is covered by a compact soil and an apron of sedimentary rocks including a few interstratified lava beds of an age later than those of the main mountain mass. The soil and finer grained sediments are relatively tight and impermeable and form the cap rock of the artesian structure, which confines the water in the underlying basalt and prevents it from rising upward. They extend up the major valleys back of Honolulu as deep valley-fills, and divide the artesian structure into several areas of different artesian pressure (Fig. 5). Wells puncturing this cap rock obtain water under pressure from the basalt below. This artesian structure is unique in that there is no lower confining bed and no seaward barrier other than the salt water of the sea.

Flotation of fresh water

Fresh water has a lower specific gravity than seawater and in a porous medium will float on the seawater, depressing it according to a certain formula (Ghyben-Herzberg principle). Based on the density of seawater near Oahu, it has been established that for each foot the fresh water stands in a well above sea level, saltwater having the composition of seawater will lie 42 ft. below sea level. Diffusion and mixing, however, tend to make the actual depth of fresh water somewhat less than the theoretical depth. Applying this principle to the Honolulu basin it is found to have an important bearing on the recovery of artesian water because for each foot the water level declines in the wells there is a rise of about 42 ft. of the underlying salt water. Heavy draft from wells in late years in Honolulu has caused many of the private wells near the shore to go salty and in times of drought the city wells are always in danger of becoming brackish.

Conservation measures

As drilled wells became more numerous the danger of saltwater invasion increased. Therefore, other means were sought to meet the water supply demands of a growing population and conservation became the order of the day.

A story is told how a Chinese man in Honolulu drilled so big a well that it affected his neighbors' wells with the result that the first law to control the waste of artesian water on the Island of Oahu was introduced into the legislature in 1884 and approved by King Kalakaua. Further legislation followed. Metering began in 1909 and a program of curtailment of waste was started, culminating in the creation of the present Board of Water Supply of Honolulu in 1929. Wells were capped, leaky wells were repaired, and the public was encouraged to conserve water.

But conservation by curtailment of waste and loss has not been sufficient. Additional water is needed on the island to meet the demands of an increasing population, and since the drilled well supplies have reached a practical limit because of the danger of invasion of saltwater, an improved method of well development was tried. This method is the Maui type of well and it has already proven its value on Oahu.

Wells for Honolulu

The first of the Maui wells to be constructed on Oahu was the Palolo shaft, east of Kaimuki (Fig. 1). It belongs to the Honolulu Board of Water Supply and was started in January 1936. It is an 8x8-ft. inclined shaft 303 ft. long with the portal at altitude of 160 ft. above sea level. A 5x7-ft. horizontal infiltration tunnel 67 ft. long with its floor 6 ft. above sea level extends inland from the base of the shaft. The fresh water level is about 10 ft. above sea level.

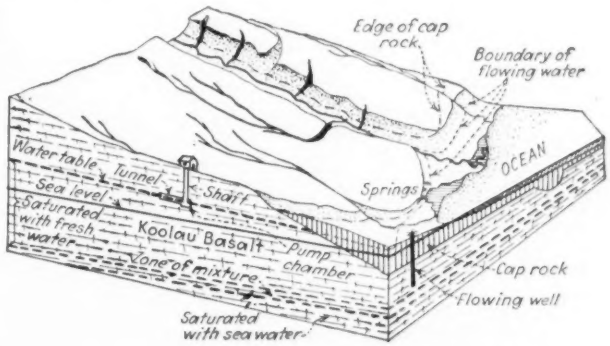


FIG. 3—GEOLOGIC STRUCTURE of a typical artesian basin on Oahu.

The shaft was started in 6 ft. layer of black soil and pebbles and then entered hard *pahoehoe* lava rock of the Koolau formation where it would tap an artesian area. (*Pahoehoe* lava has a smooth billowy surface, contains round vesicles, little or no clinker and commonly open tubes through which water can readily move. *Aa* lava contains much spiny clinker and has deflated stretched vesicles; the clinker beds are very permeable.)

The 20x30 ft. pump chamber at the bottom of the shaft is equipped with two electric-driven horizontal centrifugal pumps each with a capacity of 2 m.g.d. which will lift the water 170 ft. through 16-in. cast-iron pipe. A 10-day pumping test showed a yield of about 6 m.g.d.

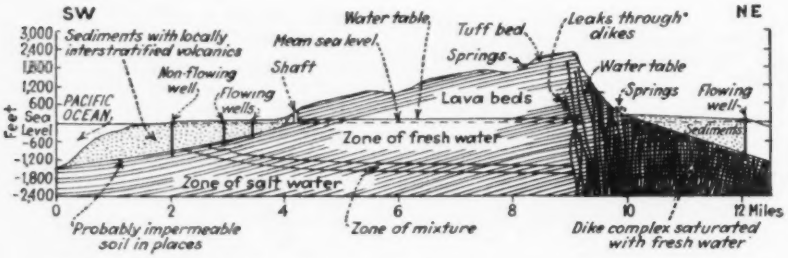


FIG. 4—CROSS-SECTION of the Koolau Range, showing the form of the cap rock and the saturated zones. Honolulu is at the left where the wells are shown.

The salt increased from 7 to 35 grains a gallon during the test.

The Kalihi shaft, (Fig. 1) also constructed by the Honolulu Board of Water Supply, was started in February 1936 and is an inclined 8.5x8.5 ft. shaft 264 ft. long, with the portal at an elevation 160 ft. above sea level. A 5x7-ft. horizontal infiltration tunnel is 85 ft. long with its floor 20 ft. above sea level extends inland from the bottom of the shaft.

The water stood 27½ ft. above sea level and a 10-day pumping test at the rate of 15 m.g.d. failed to lower the water level below 18 ft. altitude. The salt content prior to the test was about 7 grains a gallon and no change in salinity occurred during the pumping test. The drawdown was 9 in. when pumping at a 5 m.g.d. rate, 2 ft. at 14 m.g.d., and 7 ft. at a 15 m.g.d. rate.

The tunnel developed 8 m.g.d. of water from a *pahochoe* lava rock formation. The unusually large amount of water developed with so little tunnel was unexpected and gratifying. The abundance is due to the high permeability of the lava which contains numerous small caverns at the base of the shaft.

The well equipment consists of two electric driven pumps each with a capacity of 5 m.g.d. These pumps are set at altitude 28 ft. and will discharge through a 24-in. c.i. pipe. The total pumping lift is 133 ft.

Lualualei shaft

The shaft in Lualualei Valley, begun in January 1936, belong to a city and county of Honolulu and is being sunk to obtain a rural supply. The shaft is 6.8 x 7.8 ft. in cross-section and 340 ft. long with the portal at an altitude of 170 ft. Two horizontal infiltration tunnels extend away from the bottom of the shaft. Tunnel No. 1 starts 1 ft. above sea level, is 5 ft. wide, 6 ft. high and 206 ft. long. It runs inland and yields 170,000 gallons a day. Tunnel No. 2 starts at mean sea level, was 245 ft. long at the time of the author's visit (August 1936) and was still being extended. It is 5 ft. wide, 6 ft. long, and is located parallel to the coast. It was yielding 196,000 gallons a day and the water contained 35 grains of salt per gallon.

Although both tunnels and the shaft are in very dense massive *pahoehoe* lava rock which so far has yielded only 360,000 gallons a day, this amount exceeds

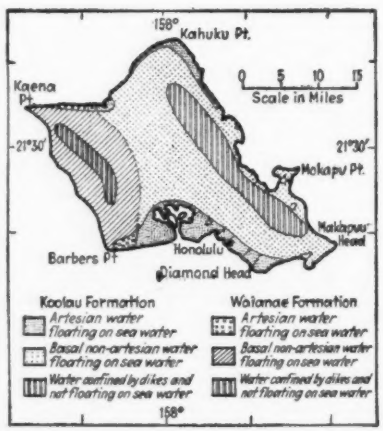


FIG. 5—DISTRIBUTION of ground-water areas on Oahu.

any thus far recovered in this comparatively dry area. The pumping head is 165 ft. and the well will be equipped with a horizontal centrifugal pump.

Sugar plantation supply

Another shaft is being constructed on the west side of Makaha Valley by the Waianae sugar plantation (Fig. 1). This was started on January 24, 1936. Details regarding its design and construction have not yet been released by the owners.

Both tunnel and shaft are in dense *pahochoe* lava rock and water pours in through crevices. The water is confined by dikes and this is the first attempt to develop confined water by a Maui type of well. Because the water is confined by dikes the yield of the well will probably gradually decline until the storage between the dikes is depleted. The yield will then equal the inflow from adjacent areas through crevices in the dikes and will be dependent upon the amount of rainfall on the recharge area.

U. S. Army and Navy wells

The Aiea shaft, near the town of that name, was started in August 1936. It belongs jointly to the U. S. Navy and Army and will be used to develop water for the Pearl Harbor navy yard and the new Hickam army air field. The shaft is 7.67x7.83 ft. in cross-section and 153 ft. long An infiltration tunnel 4.5x6.5 ft. at 16 ft. altitude is included in the contract. The portal of the shaft is 95 ft. above sea level. The well is to be equipped with two 200-hp. deep-well turbine pumps each with a capacity of 3,000 g.p.m. (4.32 m.g.d.) This type of pump is being used in order to avoid flooding difficulties due to the wide fluctuation of the water table.

The Schofield shaft of the U. S. Army is located near Schofield Barracks and it was started in March 1936. The 7.5x7.5 ft. shaft, opened at altitude 850, is 1,167 ft. long. The shaft penetrated 165 ft. of soil and rotted rock and then entered flat lying Koolau lava flows. At 276 ft. above sea level water was struck. At first it was thought that this was perched water but a diamond drill boring to 21 ft. below sea level demonstrated that there were no perching formations and that the rock was saturated all the way down. Based on the Ghyben-Hertberg principle more than two miles of fresh water underlies this site. Because of this thick, fresh water zone and the lack of knowledge regarding water-table fluctuations the water will be developed by means of wells drilled to sea level from the floor of the pump chamber.

Public Power Development Proposed for Quebec

The new government of the province of Quebec, at the opening of the 1937 legislature on Feb. 24, announced that it proposed to inaugurate the public development of the power resources of the province and to authorize cities to undertake the distribution and sale of power as a municipal enterprise.

It is generally believed that the powers of the Quebec Streams Commission will be expanded to permit it to develop and sell power, much as is now done by the Hydro-Electric Power Commission of Ontario. The Quebec Streams Commission has built and controls numerous large storage reservoirs at the headwaters of some of the principal streams in the province upon which power can be or is being developed.

Book Reviews and Notes

A Monthly Commentary on Current Additions to the Civil Engineer's Library

Ancient Uses of Bitumen

BITUMEN AND PETROLEUM IN ANTIQUITY—By R. J. Rorbes. 109 pp. Published by E. J. Brill, Leiden, Holland.

FOLLOWING HIS UNIQUE HISTORY and description of ancient roads and road construction (*ENR* Dec. 27, 1934, p. 830), Mr. Forbes has delved again into ancient writings and the discoveries of archaeologists for facts about ancient uses of bitumen and petroleum. In seven chapters on nomenclature and classification; where bitumens were found; collecting and refining bitumen, and applications of bitumen in structures, art, burial and warfare he tells a story that will interest both asphalt technologists and constructors. Numerous illustrations of ancient structures supplement the text and there is a remarkable bibliography of papers and books consulted for information.

Simple Structure Design

THEORY OF MODERN STEEL STRUCTURES—Vol. I—DETERMINATE. By Lintin E. Grinter. 317 pp. Published by the Macmillan Co., New York. Price $4.

SINCE TEXTS on elementary structural analysis are necessarily limited in the scope of their subject matter, possible variations are confined largely to presentation and arrangement. In these two respects, however, there is always room for improvement, and Professor Grinter has grasped the opportunity in the first of his two volumes on Theory of Modern Steel Structures. Discarding the outworn idea that structural design and stress analysis can be taught only by abstract precept, he takes full advantage of the use of example. Arousing the student's interest first by a review of the history of structural engineering, he disposes of the theory of stress analysis in 30 pages and then devotes the remaining 230 pages to actual structures—mill buildings, highway truss bridges, railway truss bridges, plate girders and tall steel buildings. This method of attacking the problem keeps the student constantly in touch with reality. It sustains his interest because as he assembles his knowledge he is gradually assembling an actual structure instead of merely dealing with its parts as unrelated exercises in mechanics and geometry. An incidental advantage is that the value of the text to the young practicing engineer is enhanced. Professor Grinter's book is in keeping with the modern needs of teaching.

British Structural Design

ANALYSIS OF ENGINEERING STRUCTURES—By A. J. Sutton Pippard and J. F. Baker. 554 pp. Published by Longmans, Green & Company, London and New York. Price $9.00.

THIS ADVANCED TEXT is devoted entirely to structural design theory, and its 550 pages cover all manner of structures from continuous beams to elastic arches, beams curved in plain, suspension bridges, buildings and dams. Its authors were both members of the recent steel structures research committee, and Professor Baker was the committee's technical officer. The work of this body revolutionized British practice in a number of particulars. This new thinking is embodied in the book by Professors Pippard and Baker, which may be said to reflect modern British practice in most of its particulars.

Water Plant Operation

WATER PURIFICATION CONTROL—Second Edition—By Edward S. Hopkins. 184 pp. Published by the Williams & Wilkins Co., Baltimore. Price $1.75.

THIS TEXT met with considerable favor among water-works operators when the first edition was published in 1932. It is a well-rounded and practical discussion of water purification control designed to assist operators in improving and maintaining their plants at highest efficiency. Separate chapters deal with the theory and mechanism of coagulation, sedimentation, filtration and disinfection processes. Corrective treatment for corrosive waters and methods of controlling tastes and odors are also included. An added feature is a section on water softening written by R. C. Bardwell, superintendent of water supply of the Chesapeake & Ohio Ry. Co.

European Waterways

WATERWAY ENGINEERING—By Otto Franzius. Translated by Lorenz G. Straub. 527 pp. Published by The Technology Press, Massachusetts Institute of Technology, Cambridge, Mass. Price $7.

HYDRAULIC ENGINEERS are again in debt to the late John R. Freeman because of this third important foreign language treatise the translation of which he made possible. Dr. Franzius' great text on waterways engineering has had to be abbreviated by the translator, but even condensed it gives 527 text pages, 23 tables and 576 illustrations of the most valuable information on natural and artificial waterways printed in English. The text is divided into six parts: river control; river mouths and their treatment; effect of the sea on coasts, seashore development and levee construction; weirs; ship docks, and artificial waterways. The volume is a most welcome addition to the not plentiful number of books on waterways written in English. Examples used to illustrate the fundamental principles are taken almost exclusively from European practice.

Revised Manual For Railway Engineers

MANUAL FOR RAILWAY ENGINEERING—Revised to March 12, 1936. Published in loose-leaf form by the American Railway Engineering Association, Chicago, Ill. Price: Association members $4; non-member railroad employees, colleges and libraries $7; others $10. 1,772 pp.

A RADICAL and much-needed change has been made in the manual of the American Engineering Association. Most conspicuous is its form—loose-leaf with a binding that is designed to facilitate removal of any one section or the substitution of new pages for those changed by the revisions that are made annually. But there has been a complete change in the type face that has resulted in improved readability and a change in the arrangement of the content that will make the book much more serviceable.

The usefulness of the manual both to members and non-members has been widened greatly by the change to loose-leaf form with its provision for lifting out any section. For many years the association's manual has been too bulky to be carried about, and few members need more than one or two sections at any one time. These sections now can be taken out and carried about conveniently in a temporary cover. Non-members, chiefly interested in the many specifications, now can obtain them in convenient form.

Adverse criticism hardly seems appropriate in view of the vast improvement that has been made, but it does seem desirable to point to deficiencies that are the responsibility of standing committees rather than of the committee that reorganized the manual. For example, no specifications for laying new track are included, there being only a reference to four pages of specifications printed in the 1923 *Proceedings*, a document that is not easily available to many. Adequate specifications for pile driving also are lacking. Both pile driving and track laying frequently

are among the early problems put up to the young engineer to whom the manual should be a principal working tool.

From a lighter angle, the glossary of terms peculiar to railway maintenance engineering provides at least two good laughs. A tie is defined as " a piece of wood, metal or other material, in tension, between two posts;" and a rail is defined as "any longitudinal member of a fence other than the wire." This came about through lifting definitions out of those sections of former editions of the manual that contained definitions and combining them in one glossary. It points to the need for further work before the manual comes up to its fullest possibilities.

Arrangements for expanding the usefulness of the manual by making it possible for those outside of the association to purchase copies of any section or of any one of the many specifications have not been completed but will be announced soon.

Miscellaneous Notes On Booklets and Reprints

ALIGNMENT CHARTS, their construction and use is the subject of circular No. 34, Engineering Experiment Station, Ohio State University, Columbus, Ohio. Price 40 cents.

SUBURBAN TRANSIT FOR NORTHERN NEW JERSEY has been made the subject of a special report to the legislature of the state of New Jersey by the Port of New York Authority. Copies may be obtained from the Port Authority's office, 111 Eighth Ave., New York City.

ANALYSIS of thin rectangular plates supported on opposite edges is the subject of bulletin 129, Engineering Experiment Station, Iowa State College, Iowa. Free.

TOWN-ADMINISTERED special districts and the control of local finances in New York is the subject of a special report No. 11 of the New York State Tax Commission, Albany, N. Y. Price not stated.

FIRE CONTROL NOTES is the subject of the first of a series of publications to be devoted to the technique of fire control published by the Division of Fire Control, U. S. Forest Service, Washington, D. C.

A CENTENNIAL EDITION of the *Texas Engineer*, publication of the Texas Section, American Society of Civil Engineers, has been issued in connection with the celebration of the 100th anniversary of the independence of Texas. The content of this issue is chiefly historical matter of special interest to engineers. Price, 50 cents, from the publication office, College Station, Texas.

THE CHARACTERISTICS OF SOIL that are of special interest to engineers concerned with earth fills and foundations have been made the subject of a pamphlet entitled "Elementary Soil Fundamentals" published by the University of Oklahoma. Copies may be obtained from the University of Oklahoma Press, Norman, Okla.; price, 65 cents.

THE EARLY IRON INDUSTRY of Connecticut, a paper by Herbert C. Keith and Charles Rufus Harte presented at the 51st annual meeting of the Connecticut Society of Civil Engineers, has been reprinted from the society's 51st annual report as a separate pamphlet.

TRENDS IN LAND USE in the city of St. Louis, Mo. have been made the subject of a report to the city by the city planning commission, entitled "Urban Land Policies." The report undertakes to recommend measures to preserve the stability and stimulate sound development of the land within the city limits. STANDARDS set up by the American Standards Association are listed together with the price of each pamphlet in a "Manual of American Standards," available from the Association, 29 W. 39th St., New York.

WIRE ROPE is the subject of Safe Practices Pamphlet No. 26 published by the National Safety Council, 20 No. Wacker Drive, Chicago. Price for a single copy, 25 cents.

CONTINUED STUDIES on the deterioration of structures of timber, metal and concrete exposed to the action of seawater are reported in the 16th (interim) report of the committee on this subject of the Institution of Civil Engineers (Great Britain). Price, 20 cents, British Library of Information, 270 Madison Ave., New York. This report is a brief supplement to the main report published last year as the 15th report of the committee.

FREEWAYS have been made the subject of Information Bulletin No. 33, Regional Plan Association, 400 Madison Ave., New York, entitled "The Freeway, a Modern Highway for General Traffic in Metropolitan Areas." Subscription price, $1 a year.

CONSTRUCTION PLANT and Methods for Flood Control on the Lower Mississippi River and Similar Streams; Manual of Engineering Practice No. 12, American Society of Civil Engineers, 33 W. 39th St., New York. Price, members, 50 cents; non-members, $1.

A HIGHWAY LIGHTING CODE prepared by the committee on street and highway lighting of the Illuminating Engineering Society is included in the *Transactions* of that society for February, 1937. The cost of the *Transactions* to non-members is $1 per copy. Reprints of the highway lighting code are available at 10 cents each. A large part of the February *Transactions* is given over to highway lighting questions. The address of the society is 51 Madison Ave., New York City.

New Books and Revised Editions

[*Those desiring copies of the books listed below or mentioned elsewhere in this section should order them from the publishers or from their local booksellers.*]

COMPREHENSIVE CITY PLAN FOR DUBUQUE, IOWA—Prepared by the City Planning and Zoning Commission. John Nolen, Consultant. Price not stated.

THE COLOSSUS OF ROADS—A LIFE OF JOHN LOUDON McADAM—by Roy Devereux. 184 pp. Published by the Oxford University Press, London and New York. Price $5.

THE RECOVERY PROBLEM IN THE UNITED STATES—Prepared by the Institute of Economics of the Brookings Institution. 709 pp. Published by the Brookings Institution, Washington, D. C. Price $4.

ENGINEERING PROPERTIES OF SOIL—By C. A. Hogentogler and C. A. Hogentogler, Jr. 434 pp. Published by McGraw-Hill Book Company, New York and London. Price $5.

ELEMENTS OF RAILROAD ENGINEERING—Fifth Edition—By the late William G. Raymond, revised by H. E. Riggs and W. C. Sadler. 406 pp. Published by John Wiley & Sons, Inc., New York; Chapman & Hall, London. Price $4.25.

THE SUPERVISION OF CONSTRUCTION OPERATIONS—By W. W. Beach. 488 pp. Published by Charles Scribner's Sons, New York and London. Price $6.

THE PORTS OF MIAMI AND TAMPA, FLORIDA—Port Series No. 8, Part 2 (Revised 1936)—Compiled by the Board of Engineers for Rivers and Harbors, War Department, and the United States Maritime Commission. 181 pp. For sale by the Superintendent of Documents, Washington, D. C. Price $.45.

NOTES ON SOIL MECHANICS AND FOUNDATIONS—By Fred L. Plummer. 139 pp. Obtainable from K. Cook, 10,800 Euclid Ave., Cleveland, Ohio. Price $2.

BASIC INDUSTRIAL MARKETS IN THE UNITED STATES—Gas and Electric Utilities—By O. C. Holleran. 157 pp. Published by The Department of Commerce, Bureau of Foreign and Domestic Commerce. Price $.10.

VERSUCHE AN EISENBETONBALKEN UNTER RUHENDEN UND HERABFALLENDEN LASTEN—By Rudolf Saliger and Ernst Bittner. 79 pp. Published by Julius Springer, 1 Schottengasse 4, Vienna. Price 12 RM.

ENGINEERING DRAWING SHEETS—SERIES B—By Thomas E. French and H. M. McCully. 63 sheets. Published by McGraw-Hill Book Co., New York and London. Price $2.00.

SEEHAFENBAU—Lieferung 2 (Bogen 6 bis 10) and Lieferung 3 (Bogen 11 bis 15)—By F. W. Otto Schulze. Pp. 81-240, incl. Published by Wilhelm Ernst & Sohn, Berlin W9. Price (foreign) 4.15 R.M.

CONSTRUCTION INDUSTRY—Volume II—Employment by Months, and by Occupational Groups by States and Cities, and by kind of Business. Prepared by Bureau of the Census. 164 pp. Published by Bureau of the Census, Department of Commerce, Washington, D. C. Free.

Letters to the Editor

Malaria and Floods

Sir—In reply to your letter asking what might be the effect of floods in the Ohio and Mississippi Valleys on mosquito breeding and malaria transmission, I would say that this depends on several variable factors. There will be an increase of *Anopheles* (the only species of mosquito capable of transmitting malaria) provided:

(1) Backwaters get into depressions and remain there until the *Anopheles* breeding season starts. In large measure this depends on rainfall distribution between now and that time. Also of considerable importance are the collection of rafts of flotage that may form on ponds and other bodies of water—floating debris protects mosquito larvae from their natural fish enemies. It is for this reason that brush and trees are constantly being cleared from the large hydro-electric impounded water projects in the South. The cost of such work may be anywhere from $50,000 to over a million dollars or more per project.

(2) Another factor will be the effect of present Mississippi River levels on water elevations in the lower Mississippi Valley as, for instance, in Louisiana and Mississippi where the *Anopheles* breeding may start months sooner than in the latitude of Memphis, Tenn. Research work carried on by this office several years ago indicated also that *Anopheles* propagated a month earlier in flotage rafts in overflow water than they did in nearby potential breeding places within a half mile thereof. The reason for this is not yet known.

(3) If the recent flood keeps the Mississippi River higher than normal in March, April, and May, tributary streams in Mississippi, Louisiana, and southern Arkansas because of this condition, plus the likelihood of heavy local spring rains, may develop high elevation backwater. This will facilitate the formation of debris flotage rafts and as a result there may be an *Anopheles* crop many times the normal size. Malaria prevalence can then be expected to climb accordingly.

(4) A controlling factor of critical importance would be the arrival of an early spring season with warm afternoons or evenings. The flight of *Anopheles* at dusk and until morning is a function of temperature—at 65 deg. F. and below you may see one *Anopheles* mosquito an hour, but at a temperature ten degrees higher it would not be unusual to have a thousand mosquitoes swarming about.

J. A. LEPRINCE

Senior Sanitary Engineer,
U. S. Public Health Service.

Memphis, Tenn.
Feb. 28, 1937.

Oklahoma Dust in Michigan

Sir—On the morning of Feb. 8, after a blizzard from ESE which was in force from 12:55 a.m. to about 7:30 a.m., a fall of icy snow occurred which contained mud sandwiched between flakes. To check the amount of soil, twenty circles were cut through the crust formed by this ice at intervals of 10 to 11 in. in line of wind, using an 8-in. rain-gage funnel, and the snow so obtained was melted and filtered. The residue, dried in air and measured by weighing on a chemical balance, weighed 24.5 grains. These 24.5 grains on twenty 8-in. circles would amount to 6.98 tons per sq.mi. Sault Ste. Marie reported 10.35 tons per sq.mi. in a newspaper statement and I learn that there was no record of dust just on this side of Marquette.

Description of barometric conditions in the Sunday *Times* (N. Y.) indicates a low over Oklahoma and a high in Alberta heading this way at 8 p.m. Feb. 6 to form the area as shown in *ENR*, Feb. 4 issue, page 198.

Radio and newspaper reports gave several states as origin of dust while the U.S.W.B. Weekly Weather and Crop Bulletin of Feb. 9 gave Kansas, Oklahoma, and New Mexico as centers of dust storms. On snow, the dust is yellow brown. In water it is a dark brown precipitate leaving a smoky water. Dried, it is dust or clay colored. A smear on cellophane shows perhaps 60 per cent transparent grains and opaque dark specks of soil. A sand grain 200 times magnified was perhaps ¼ to ½ area of the lead in a pencil, faceted, ellipsoidal shaped and water clear. This grain was perhaps 3 to 5 times as large as the majority of the grains around it, or about 1/20,000 in.

R. R. RYAN

Newberry, Mich.
Feb. 23, 1937

A Neglected Courtesy

Sir—Allow me to commend you for the thoughtful and impressive note on p. 97 of the Searchlight Section of the Feb. 4 issue directed to employers who advertise for men.

To me it has always seemed a most inhuman act on the part of some organizations for failing to acknowledge the receipt of the unsuccessful applicant's letter. Surely, those who are guilty of such laxity cannot be so immune to human sensibilities as to ignore those of us who are struggling for recognition. Can they not realize that the applicant patiently waits and hopes for a favorable reply for three or four weeks after submitting his application, realizing that the consideration given to the employment of new men may not always be a hurried procedure?

The question of the expense of replying to all letters when only several are considered, is obvious. If such is the defense, let the company meditate on the fact, that if the applicant is willing to risk his time, efforts, and materials for the attainment of a mutual benefit, surely he is worthy of that much consideration in return, regardless as to who can better afford the expense.

I may add that this letter does not reflect any disillusionment or loss of faith on my part for failing to receive replies to letters of application. On the contrary, I usually gain more confidence, as I would not care to work for a company who is so inconsiderate in such small matters.

I found your notice to be very encouraging.

GEORGE E. SOMMA

White Plains, N. Y.
Feb. 8, 1937

Highway Risk Factors

Sir—Your issue of Jan. 7 contains much of interest regarding road construction.

From the standpoint of use of the roads, is sufficient care taken to make bridges of an adequate width? Page 20 of your issue shows a bridge of adequate width, but too often they are found to be barely the width of the pavement and in many cases somewhat narrower. In broad daylight no very great danger arises, but if at night, especially if foggy or rainy, a car going the other way is met at one of these bridges, a very great danger arises. I have seen a car upset while it was still light in this case; however, the driver was nearly blind and did not see the bridge. A road should be so constructed that it is safe even under adverse conditions.

Would it not be better in all cases except in towns to have a gravelled or stone shoulder wide enough to park entirely clear of the pavement and then make it obligatory not to stop on the pavement? They have or did have this rule in California.

In the East and South, signs are not properly placed. As a rule, they are directly at road intersections and generally in small letters, making it necessary to stop in order to read them. In the West, usually, a sign is placed in advance of the intersection giving directions so that the driver knows just what to do and does not have to stop.

In these days of high speed a great deal depends on proper layout of the roads and adequate signs.

ROBERT S. SMITH

Biloxi, Miss.
Jan. 11, 1937

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Editorial offices at 330 West 42nd Street, New York

March 25, 1937

Construction Labor

ANY HOPES within the construction industry that the present labor unrest will pass it by are dispelled by recent events on the Colorado River Aqueduct job. On this large western project the CIO has already made its appearance, and has forced the District authorities to make substantial pay increases for both underground and surface men. Though refusing the union's demands for preferential hiring and granting less than the full wage raise asked for, the board of the district stated that increase in cost of living warrants additional compensation. So far only the force-account workers benefit, but the contractors on adjacent sections may be forced to fall in line. How far such unrest will spread to other construction work is a matter of conjecture, but the industry is certain to face labor demands in many parts of the country. A change in the labor situation is coming, and—like it or not—construction must be prepared to meet it.

Keep Power Out

AT A STREAM-POLLUTION CONFERENCE called to discuss steps to clean up the Potomac River, a speaker advocated that the power possibilities of the river should be studied at the same time. The matter under discussion had nothing to do with power. The condition of the Potomac is notoriously bad, especially as to industrial pollution, and for this reason the prospect that half a dozen states are prepared to join hands in abating pollution is a welcome sign of progress. Under such conditions, why anyone should see fit to throw the undertaking into confusion by injecting the wholly extraneous matter of power is hard to understand, especially as such action would tend to delay progress by stirring up controversy. Perhaps it is explained by the fact that power development has become an obsession in some minds, and that whenever any river problem is being considered the thought springs up that a power business might as well be started up at the same time as a profitable sideline. The absurdity of yoking power to stream cleanup should be apparent, however, even to those who have ultra-optimistic ideas about water-power profits.

The Dust Still Flies

LAST JUNE NEW YORK STATE enacted a law to reduce the silicosis hazard in rock drilling and excavation. Nine months have passed, but the law is still inactive, awaiting action of the Industrial Commission in formulating a code for its application and administration. An advisory committee on the code met several times last summer and fall in an effort to iron out conflicting desires of labor, construction interests, medical experts and manufacturers. Hope for action rose in November when the state conducted tests of dust-control devices, but died again as weeks passed without announcement of any results. Finally on Jan. 28 a public hearing was held on the code, but after protests by cement and gypsum interests over the technical definition of silica-bearing rock the code was thrown back into the lap of a medical subcommittee. Nothing further has been heard from the Commission. Why quibble over the definition? The New York labor law provides for exceptions under justifiable conditions. While a humane law lies dormant, labor remains without health protection, contractors know not where they stand, insurance carriers are uncertain as to their responsibility, and manufacturers are waiting for approval of their apparatus. The situation is of more than local interest, for other states are looking to New York as a guide to their own legislation. While delay follows delay, the dust continues to fly uncontrolled.

Horizontal Wells

DURING THE THIRTY OR FORTY YEARS since the relation between fresh and salt water in the underground reservoir of coastal regions was first worked out the proper handling of large-draft wells in such regions has undergone progressive improvement. Today it is recognized that the draft on such wells must be limited to the dependable amount of recharge. Yet even under favorable conditions the ordinary (vertical) well is at a disadvantage because of its necessarily deep penetration into the groundwater reservoir. The case is particularly difficult where the surface of the groundwater is not far above tide level. Under such conditions, there is obvious advantage in the horizontal well or infiltration-gallery system that is being applied in Hawaii on increasing scale, according to Mrs. Stearns' account on another page. These wells or galleries function as skimming devices, taking fresh water from the top of the supply; properly built in the first place and then operated within capacity limits they are efficient and foolproof, and no salt can reach them except for the possible effect of diffusion. While the Hawaiian lavas present ideal conditions for such gallery construction, the waterbearing sands of many coastal areas are also adaptable to the system. The greater cost of horizontal wells as compared with vertical wells will often be justified by the assurance of longer useful life.

Somebody's Face Should Be Red

SANITARY ENGINEERS who are constructing separate sludge digestion facilities at sewage disposal plants had better change their oldfashioned ideas. It makes no difference that hundreds of plants are using this process, that it has been adopted at some of our newest and largest installations, and that it offers a means whereby valuable gas is recovered to generate power. On the contrary, the method is "recognized as rapidly becoming obsolete . . . requiring the utilization of detention tanks wherein the sewage sludge is held for weeks while undergoing violent putrefaction." Our authority is a former member of a commission now engaged in the construction of a major sewage plant in the East. This "expert" (who was a secretary prior to his appointment to the commission about a year ago) recently resigned; he declined to continue on a group sponsoring the construction of a sewage plant that will be, according to published reports, "a shame and a disgrace and a fraud" on the people of the city. As this individual is said to have attended few meetings of the commission, we assume that his conclusions were independently reached and unsullied by contact with the sanitary engineering world.

He may be right about the obsolescence of separate sludge disposal, though for the present we place more faith in the experience and opinion of those who have studied the subject deeply.

Cracking Down

FEDERAL HIGHWAY AUTHORITIES have told the Maryland commission that unless it can present a sound defense for its action in diverting motor vehicle taxes one-third of its 1937 federal-aid money will be withheld under authority of the Hayden-Cartwright federal-aid law. The alleged condition of Maryland highways that has prompted this drastic action is told in the news pages that follow. True friends of the road will welcome this action by federal authority; indeed, the Bureau of Public Roads could be criticized only for delaying too long in exercising its punitive powers against road-tax diversion. Now that action has been taken, let us hope that it will be pressed and extended. Many states besides Maryland need a lesson in road-tax honesty. Not far north of Maryland, New Jersey has been a particularly conscienceless offender, but a dozen other states are little behind in misuse of road funds. That the federal congress should continue to vote road money to replace state road funds used for other purposes goes far beyond any duty of national aid to road transport. Naturally, therefore, reports that many federal legislators are growing exceedingly impatient of refinancing states for road funds spent for other purposes come as no surprise. The plain fact is that unless offending states correct their practices the country will soon face a revulsion of present sentiment in favor of continued large federal-aid appropriations.

Time to Reorganize

SYSTEMS under which organizations conduct their work frequently become a check upon the organization's effective functioning before it is realized that they need revamping. This is especially true of technical societies, where changes are difficult to make. The American Railway Engineering Association has suffered from this handicap for some years, but only recently has it been recognized that the check on the association's effectiveness lay in the multiplicity of the committees by which the association carries on its work.

There now are thirty standing and special committees, many of which have closely related or even overlapping functions; while some have managed to keep their functions separate, others have not, and the conflicts have been unfortunate incidents of all recent conventions. At last week's convention the matter of reorganizing the association's committee work was raised formally when the subject of impact came up under the report of the committee on wood bridges and trestles.

The association has a special committee on impact, which has confined its studies chiefly to impact on steel bridges. It also has a committee on iron and steel structures and a committee on masonry, which latter by a process of evolution has taken on reinforced-concrete bridges as one of its chief interests. Thus four committees are concerned with impact. The questions put up to the board of directors was why there should not be one committee on bridges with subcommittees on wood, steel, and masonry structures, thereby centering all subjects of mutual interest such as impact in one general committee to avoid the conflicts that now waste valuable time.

For most effective functioning the whole set-up of the A.R.E.A. needs restudy. The present committee arrangement is unsystematic, the result of growth as new needs developed. As an example, there are separate committees on roadway, ballast, rail, ties, track, and stresses in track, all of which are so closely related as to suggest that they might well be under one head.

Throughout its history the A.R.E.A. has been noted for its accomplishments in gathering and organizing data of value to its members. Two years ago it took a radical step in deciding upon a complete reorganization of its manual. That work now has been completed and the greater usefulness of the manual already is clearly apparent. A second radical step now is called for; the association should reorganize its committee system.

The groundwork already has been laid in the "complete outline of work" that each committee undertook to prepare last year. With these outlines available to show where overlapping may or does occur, it should be possible to lay down a new committee system that will simplify the work of the standing committees and increase their usefulness.

The Texas School Disaster

THE APPALLING DISASTER that took the lives of some 400 high school students in the small community of New London, Texas, emphasizes the necessity for unrelenting effort to attain absolute safety in public buildings. In schools above all, no detail is too unimportant for study of safety.

On the meager information at hand the New London school appears to have had no major structural fault but to have collapsed solely because of the well-nigh irresistible force of the explosion. Nevertheless, searching scrutiny may show that some construction details contributed to the extent of the collapse. Official inquiry should be so thorough as to remove all doubt on this point. The investigating authorities, who rightly state that they are seeking to determine the cause and not to find someone to blame, should include full examination of the structure as well as of its operation.

If gas vents were not properly installed, what was the fault? If conventional hollow-tile walls formed natural gas-collection chambers, what change in design might have made them safe? If a basement can accumulate an explosive gas mixture, what degree of ventilation will remove the hazard? If any structural features of the building played a part in its complete collapse, what were they, and how may safer building be assured in the future? This last question ought not to be neglected.

It is out of the question, of course, to demand that buildings shall be made proof against all explosion effects. Nevertheless, in view of the utter demolition of walls, roof and steel frame of the New London school, engineers and architects may well subject their thinking on structural stability to new scrutiny. It is not too much to expect that a building frame shall be sturdy enough to survive even though storm or explosion strip away its roof and walls. The Texas inquiry should throw clear light on causes and should leave unexplored no detail that might contribute to making our schools safe against disaster.

CURRENT NEWS

Water Supply Held City Function

U. S. Supreme Court holds water supply is municipal function and water officials' salaries are tax-exempt

The U. S. Supreme Court, in a 7 to 2 decision March 15, supported the income tax exemption claimed by chief engineer W. W. Brush, of the New York City bureau of water supply, on the salary paid him as a statutory official under legislative designation. His designation as a state agency official classifies his salary as coming within the exemption accorded by the federal revenue act.

This decision of the court overrules the commissioner of internal revenue and reverses the U. S. circuit court of Appeals. The decision is in line with the unanimous opinion delivered by the Supreme Court Jan. 6, 1937, granting R. R. Rogers, counsel for the Panama R.R., exemption because his position was authorized by congressional act and his employer, the Panama R.R., had received recognition as an agency of the federal government.

The court decision, in the Brush case, stated that the New York legislature of 1833 empowered the city to own and operate its own water system as an exercise of its police powers over the city's public health. Subsequent legislation increased the city's powers in this respect and made its water department chief engineer a statutory officer.

The Supreme Court decision of March 15 brings the statutory salary of a chief engineer within the immunity declared in the federal revenue act. It does not, however, exempt his other income from taxation. The decision does not apply, of necessity, to future suits which may come before the commissioner of internal revenue or before the federal courts on appeals which are based on different facts concerning employment.

The minority opinion in the case leaves aside the question of the separate taxing powers of the federal government and of the state. It holds the chief engineer's salary taxable because the character of his employment may be called a commercial one as distinct from routine official activities of a political office. The use of commercial employees in government service, whether artisans, clerks, or professional men, according to the minority opinion, should not give rise to an immunity from the income tax not granted to private employees on similar projects.

Limitations of the decision

That this decision cannot be taken as a general rule and guide for tax exemption claims by city employees is indicated by the decision in a previous case brought by the trustees of the Boston Elevated R.R. In this case the Supreme Court denied the trustees tax exemption on their salaries. The Massachusetts legislature had passed a special act recognizing their duties as those of a government agent; but, said the court, the state cannot withdraw all sources of revenue from the federal taxing power by engaging in a business which constitutes a radical departure from usual government functions. Immunity from income tax by salaried employees cannot be claimed merely because the state engages in a business which it considers to be a public benefit.

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Anonymous Gift to Cal. Tech To be Used for Humanities

A gift of $750,000 has been made anonymously to the California Institute of Technology, subject only to the stipulation that it be used in the humanities section of the curriculum. The money will be used chiefly in the field of literature, history, economics, foreign languages, and philosophy.

The donor expressed his interest in "the work which the Institute is doing in developing the humanities, thus enabling engineering students to obtain the cultural side as well as the scientific."

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TVA Upheld in Georgia

The Fifth Circuit Court of Appeals, sitting at New Orleans, on March 17 upheld the decision of Judge E. Marvin Underwood, of the U.S. District Court for the Northern District of Georgia, voiding the injunction against further expansion of TVA power activities insofar as the state of Georgia is concerned.

Judge Underwood issued his ruling on January 19, 1937, stating that his court has sole jurisdiction over TVA activities in Georgia and that it alone could enjoin further expansion. He also rebuked the Georgia Power Company for withdrawing a pending suit in the Georgia court shortly before joining with 18 other utility companies in the Tennessee suit before Judge Gore.

Preparatory to a hearing set for April 16 on the suit of 19 utility companies against the Tennessee Valley Authority, government attorneys on March 16 filed a brief with the U.S. Circuit Court of Appeals at Covington, Kentucky, supporting their previous motion for dismissal of the injunction granted three months ago by Judge Gore, of the District Court.

The brief sets the cost of the injunction to TVA at $200,000 per month, and charges that during the period of enforced suspension of its power expansion activities the private utilities have been free to tie up potential customers with long-term contracts and to build rural lines skimming the cream from areas in which TVA planned to operate. It also repeated the contention that Judge Gore's court had no jurisdiction in the case.

Maryland Penalized By Road Bureau

Federal Bureau of Public Roads reduces state's federal-aid funds one-third because of tax diversion

The U. S. Bureau of Public Roads has notified the state of Maryland that its federal-aid apportionment will be reduced one-third, or $341,666, on the ground that "there has been substantial diversion of the revenues derived from motor vehicle license fees and gasoline taxes to other than highway purposes during each of the state's fiscal years 1936 and 1937, within the meaning of section 12 of the Hayden-Cartwright act of June 18, 1934, and as a result the state is subject to the deduction required by said act from its apportionment of federal-aid funds. . . . From the $1,025,000 apportioned for the federal fiscal year to end June 30, 1937, one-third, or $341,666 will be deducted."

The authority for the action to be taken by the U. S. Bureau of Public Roads arises from a provision of the Hayden-Cartwright act in 1934. In this act it is provided that if in any fiscal year a state increases its diversion of highway tax money to other purposes, the federal-aid apportionment of that state may be reduced by one-third (*ENR*, Feb. 25, p. 315). This is the first occasion on which the provision has been invoked.

Governor Nice of Maryland, when informed of the state's loss of federal aid, immediately advocated the cancellation of all diversion and urged that all money diverted in the past be restored to the highways as recommended in his budget.

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Northern-Wantagh Parkway Extension Planned

Plans have been completed by the Long Island State Park Commission and the New York State Department of Public Works for the construction of the Northern-Wantagh state parkway extension in Nassau county. This 9½-mi. parkway project will start at the present eastern terminus of Northern State Parkway at Glen Cove Road, extending easterly and south to connect with the Wantagh state parkway at its junction with the Southern State Parkway.

The parkway design provides for divided concrete roadways, each two lanes wide, and separated by a 9-ft. uniform width of landscaped mall. Bridges will be of ornamental stone faced design similar in type to other state parkway grade elimination structures. The construction schedule calls for the completion of 18 grade separation structures this year. The grading, drainage, paving, and landscaping on the parkway will start early in 1938 so that the entire parkway can be completed and opened to traffic in the spring of 1939, for the New York World's Fair.

Wide World Photos

SEARCHING THE RUINS

RESCUE WORKERS search tangled piles of steel and masonry to bring out dead and injured children and teachers from the consolidated rural school at New London, Texas, which was wrecked by an explosion on March 18.

Gas Explosion in Texas School Wrecks Building, Killing 455

After a week of questioning by a Texas National Guard court of inquiry, the events and conditions which preceded the explosion that wrecked the New London, Texas consolidated rural high school on March 18, killing 455 persons, are being fitted into a logical pattern. The school, an E-shaped assembly of buildings in which the center stem was three stories high and the wings one and two stories, was heated with individual gas-fired radiators in each room, the gas being piped in from a nearby oil field.

Formerly the gas had been purchased from a utility company, but in January a connection was made to a waste gas line from a natural gasoline stripping plant. In some manner this gas escaped, and, being odorless, accumulated undetected in some confined space. The latest testimony inclines toward the theory that the collection chamber was an unventilated subbasement some 300-ft. long beneath the three-story center building and that an electric switch on a sanding machine in the manual training department, near a trap door into this space, supplied the ignition spark.

An earlier theory, advanced by E. O. Schoch, professor of chemistry at the University of Texas and a member of the court of inquiry, was that the gas accumulated in the hollow tile back-up walls. This was held to be possible since each of the 52 individual radiators was vented into tile conduits in the wall leading up to the roof loft. Although the conduits were plastered, it is held that breaks in the plaster at the joints would have permitted gas to escape into the adjacent hollow tile.

The buildings were of steel frame construction, wall columns supporting the roof trusses. The floors were concrete slabs and the walls holow tile faced with brick. The architect of the school, which was about four years old, was T. Roy Ainsworth of Houston.

Hydraulic Engineer Dies

David L. Yarnall, senior drainage engineer, U. S. Bureau of Agricultural Engineering, and a leading figure in the field of experimental hydraulics, died suddenly at his home in Iowa City, Ia. on March 9, 1937. He was 52 years old. Mr. Yarnall graduated from Iowa State College in 1908; he received the degree of civil engineer from that institution in 1916 and the degree of master of science in hydraulic engineering from the State University of Iowa in 1926.

Mr. Yarnall joined the Department of Agriculture in 1909 immediately after his graduation from college, and for seven years he was engaged in field investigations and surveys of drainage and flood control projects in various sections of the country. In 1916 and 1917 he conducted important experiments at Arlington, Va. on the flow of water in drain tile, and in 1922 he was placed in charge of hydraulic investigation at the hydraulic laboratory in the University of Iowa, the work being carried on under cooperative agreement between the Bureau of Agricultural Engineering and the university. In this assignment he continued to do definitive work in the flow of water in through culverts.

In 1929 Mr. Yarnall made what was perhaps one of the first attempts in the United States to determine, in advance of actual field construction, the benefits to be derived from straightening rivers, when he made model tests of proposed cutoffs in the Des Moines River at Ottumwa, Ia. Mr. Yarnall was the author of more than 25 bulletins and papers, including a monumental study of rainfall frequency intensity data, published in 1935, in which he made an analysis of 28,077 rain storms, representing the combined record of every Weather Bureau station equipped with automatic rain gage in the United States from its beginning to the end of the year 1933. His support of the Iowa Hydraulic Laboratory during its early years was a large factor in its rapid development, and his use of graduate students as assistants was beneficial to scores of young men.

Express Highway Plan Drafted in New York

Superintendent of Public Works proposes $300,000,000 13-year program of express highway building

Construction of a system of express highways, 4 to 8 lanes wide, which would involve an expenditure of $300,000,000 over a 13-year period, was urged March 16 by Col. Frederick Stuart Greene, New York State Superintendent of Public Works, in his annual report to the legislature. Stating that the heavy increase in traffic in recent years has rendered the state's present highway system inadequate, Colonel Greene said, "The system is now not only trailing present day requirements, but has not kept step with the advances made by our sister states.

"This falling behind in highway construction has been especially noticeable during the past three years."

The report suggested that main traveled routes in the state should be straightened, widened and generally improved "in order that they shall become superhighways by 1950." Main routes which Colonel Greene would develop into express highways as soon as possible include:

A new road parallel to the Boston Post Road connecting at the Connecticut line with the Merritt highway.

A new highway to parallel Route 17 from the New Jersey line to a point north of Middletown.

A new road east of the Hudson River from New York to Albany.

Improvement of the road on the west side of the Hudson from New York to Albany.

Extension of the Sunrise highway to Southampton.

Improvement of the road from Saratoga Springs through Glens Falls, Lake George, and Chestertown.

Improvement of the highway from the Pennsylvania line to Binghamton, Cortland and Syracuse.

A road to parallel Route 22 from White Plains to Brewster.

Improvement of Route 20 from the Massachusetts line through Albany to Buffalo.

"Of these highways," the report stated, "the one from New York City to the Connecticut state line and the new proposed highway paralleling Route 17 are the most urgently needed, and construction should be started at once."

Dust Exhaust Systems Report Issued by A. S. A.

A report on fundamentals of design and operation of dust exhaust systems, bearing on occupational disease prevention, has been issued by the American Standards Association, 29 W. 39th St., New York City. It is part of the report of the Engineering Committee of the Silicosis Conference, presented at Washington Feb. 3. The subcommittee on exhaust systems was headed by Theodore Hatch, Division of Industrial Hygiene, New York State Department of Labor.

The report covers plant layout, exhaust hood design, air velocities, methods of measuring static suction, exhaust-pipe lay out and maintenance, etc.

Railroad Engineers and Manufacturers Hold Meeting and Show in Chicago

American Railway Engineering Association and the National Railway Appliances Association gather in Chicago for annual meeting and display of equipment used in railway construction and maintenance

WELL over a thousand railway engineers and representatives of manufacturers of equipment used in railway construction and maintenance met in Chicago March 15-18 for the 38th annual meeting of the American Railway Engineering Association and for the exhibit of the National Railway Appliances Association. The total registration of A.R.E.A. members and guests was 984 as compared with a few over 900 in 1935 and 1936.

Rail mill visited

Meetings of the A.R.E.A. were scheduled to begin on Tuesday, but over 500 members came to Chicago on Monday in response to an invitation from the Carnegie-Illinois Steel Corp. to visit that company's mill at Gary, Ind. to see the U.S.S. Brunorized Rail Plant in operation. Twenty buses picked the party up at the Palmer House in Chicago, took the members to the South Shore Country Club for lunch and from there to Gary where the party went through both the wheel mill and the rail mill. The latter mill includes the recently installed Brunorized rail plant for heat-treatment of rail to improve its physical properties. A description of the plant was published in these pages last week (*ENR*, March 18, p. 526).

Research work

Regular sessions of the A.R.E.A. were opened on Tuesday by A. R. Wilson, president, who spoke on the importance of research in the work of the association. He was followed by J. M. Symes, vice president of the Association of American Railroads, of which the A.R.E.A. is the construction and maintenance section; he outlined briefly the association's plans for expanding its research operations. The same subject was touched on subsequently by E. H. Fritch, secretary, in his annual report, in which he stated that Mr. Wilson had appointed a special committee to report on research to be conducted under the expanded program of the parent organization. This committee has recommended that a civil engineering research advisory committee be set up to pass upon research proposed to the association, to suggest how and where it should be conducted, to schedule the work, and estimate its cost. The committee further proposed that the work be carried out under the supervision of an assistant to the director of engineering research of the A.A.R. who should be specially qualified for such work. These recommendations have been transmitted to the parent organization with the approval of the board of directors of the A.R.E.A.

A report of the technical matters considered by the association will be published in next week's issue.

Secretary to retire

Retirement of E. H. Fritch who has served as secretary of the association since it was organized 38 years ago was announced at the close of the meeting, the retirement to become effective at Mr. Fritch's convenience. In making the announcement, President Wilson stated that Mr. Fritch had asked to be relieved, having reached his 77th year. Following the announcement, a bronze plaque recording the association's appreciation of Mr.

E. H. FRITCH who is to retire after 38 years as secretary and assistant secretary of the A.R.E.A.

J. C. IRWIN, new president of the American Railway Engineering Association.

Fritch's services was presented to him by E. M. Hastings.

New officers of the association were elected as follows: president, J. C. Irwin, valuation engineer, Boston & Albany R. R.; second vice president, E. M. Hastings, chief engineer, Richmond, Fredericksburg & Potomac RR.; directors, F. L. Nicholson, chief engineer, Norfolk Southern Ry.; C. S. Kirkpatrick, chief engineer, Missouri Pacific Lines; and J. B. Hunley, engineer bridges and structures, C.C.C. & St. L. Ry. F. E. Morrow, chief engineer, C. & W. I. R.R., becomes first vice-president.

After Mr. Irwin had taken the chair, Hermann von Schrenk presented him with a gavel made from wood cut from one of the white pine stringers used to support the strap rails of the first track laid in building what is now the Syracuse division of the New York Central System. The gavel was inscribed as coming from Mr. Irwin's associates in the engineering department of the New York Central System.

Railway show

Over one hundred manufacturers of railway equipment and appliances had exhibits at the railway show of the National Railway Appliances Association held in the Coliseum, an increase of nearly twenty over the number exhibiting last year. Few entirely new products or pieces of equipment were shown, but there were many evidences of improvement in equipment that has been available for some time. The show served to add emphasis to the reports of A.R.E.A. committees on the extent to which railway maintenance operations now are mechanized.

Wednesday evening, following a custom established some years ago, the Western Railway Club was host to the A.R.E.A. and the N.R.A.A. at a dinner at which Prof. Arthur N. Talbot, chairman of the joint committee on stresses in railroad track, was scheduled to speak on "The Relation Between Track and Rolling Stock." Because the amplifying system in the hotel ball room in which the dinner was held was out of order Dr. Talbot was unable to speak to the 700 club members and guests but the club president announced that copies of the speech would be made available to those desiring it.

New president

J. C. Irwin, valuation engineer of the Boston & Albany R. R. at Boston, who was elected president of the A.R.E.A. has been connected with the New York Central System continuously since 1892, two years after his graduation from the University of Pennsylvania. His early work on the railroad was with the signal department, through which department he rose to the position of superintendent of construction in the electrical zone and resident engineer on the Grand Central Terminal work in New York City. Following that work, Mr. Irwin was made chief engineer of the Rutland R. R. in 1909 and continued in that position until 1912 when he was transferred to the Boston & Albany. He was appointed valuation engineer on the Boston & Albany in 1914.

Construction on the Mississippi

During the last 6 months of 1936, U. S. Army engineers report, 26,680,000 cu. yd. of earthwork was placed in levees, mostly on the main river project below Cape Girardeau. This makes a total of 620,103,000 cu. yd. placed since June 1, 1928. Nearly 2 miles of revetment was placed from July to December, 1936.

RAILWAY EQUIPMENT SHOW held in the newly redecorated Coliseum in Chicago, March 15-18. This picture is of the main hall; part of the show was in an adjoining exhibition hall.

Washington Highlights

By Paul Wooton

President Roosevelt has nominated Col. Francis B. Wilby to be a member of the Mississippi River Commission.

The Board of Army Engineers has decided to make a detailed survey of a $3,384,000 navigation project on the Connecticut River between Hartford and Holyoke.

A request of the state of Pennsylvania for liberalization of the PWA offer to provide up to $20,000,000 for an institutional building program has been refused by PWA officials. It is understood that the plea will be taken to President Roosevelt.

The Senate has passed and sent to the House a bill amending WPA regulations to permit residents of one state to work on projects in an adjacent state. Although passed specifically to permit workers of Washoe and Churchill counties, Nevada, to be used in the construction of a dam on the Little Truckee River in California, the bill is so phrased as to apply to similar cases elsewhere.

Flood control work in the southern part of New York state will be carried out by contract, rather than with CCC labor, according to an announcement by President Roosevelt. This decision was reached after a conference between Army engineers and CCC officials, at which it was agreed that work could be done more quickly and more economically under the usual contract arrangement. The policy also conforms with the recently-announced CCC decision to confine its future efforts to reforestation on conservation activities exclusively.

Office space needs of the various government agencies in the District of Columbia will be surveyed and a recommended building program covering the next five- and ten-year periods will be drawn up by a five-man committee appointed for the purpose by President Roosevelt. Despite the completion of a number of new government buildings within recent years, the Federal Government is still paying, in the District of Columbia, over $2,000,000 annually for rented office space. Members of the committee are Harold L. Ickes, Senator Thomas, of Oklahoma, representative Collins of Mississippi, Rear Admiral Peoples, director of the Procurement Division of the Treasury Department; and Frederick Delano, chairman of the National Capitol Park and Planning Commission.

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Upper Deck to be Added To Henry Hudson Bridge

An upper level will be added to the recently completed Henry Hudson Bridge over the Harlem River at New York City, it was announced on March 21 by Park Commissioner Robert Moses, sole member of the Henry Hudson Parkway Authority. The second deck is to be added to care for the increase in traffic expected to follow the completion this fall of the West Side express highway in Manhattan from 72d St. to Dyckman St.

The upper level and a new connecting roadway will be used for northbound traffic while the existing bridge level and the present roadway will be used for southbound traffic only.

The foundation and superstructure of the bridge were built to support a double roadway. This provision for two stage construction was made at the request of the private bankers who floated the loan of $3,100,000 for the construction of the Henry Hudson Parkway. At that time an unusually conservative traffic forecast of 9,700 vehicles per day was necessary in order to secure the loan. The bankers agreed to loan a further $1,400,000 for constructing the upper deck when traffic warranted. Experience to date, Mr. Moses stated, shows that revenues will cover even more than the additional $1,400,000 originally agreed on, and an issue of $2,000,000 will be asked.

Permission of the present bond holders for the new issue will be asked at once. The entire work, including widening of the parkway immediately north of the bridge, will be completed in about six months.

Sewer Authority Member Resigns

R. Boasberg resigns from Buffalo Sewer Authority, attacking design of project—Engineers reply

Charging that the design of Buffalo's $15,000,000 sewage disposal project was unsound and that on the completion of the program "the pollution will remain practically unsolved", Robert Boasberg resigned from the Buffalo Sewer Authority on March 15.

At the same meeting at which Mr. Boasberg's resignation was announced, the authority awarded the contract for three units of the incinerator equipment for the sewage disposal plant to F. H. McGraw & Co., New York City, on its low bid of $258,000. Mr. Boasberg had favored awarding the contract to the second bidder, Nichols Engineering & Research Corp., New York City, who had bid $298,750; Mr. Boasberg, it was reported, contended that the Nichols company equipment was superior.

Mr. Boasberg was appointed to the Buffalo Sewer Authority in October, 1935. He was a former private secretary to Mayor Zimmerman of Buffalo and was appointed by him to a vacancy on the board at a time when the board was deadlocked on the choice of an engineer for the project. Mr. Boasberg's vote swung the decision in favor of Clyde Potts of New Jersey. Mr. Potts' appointment was cancelled by PWA Administrator Ickes, and the present engineers, Greeley & Hansen, were subsequently appointed.

Unsound design charged

In his letter of resignation to the Mayor, Mr. Boasberg stated that the plan as projected will remove at most only 40 per cent of the sewage solids. He charged that "60 per cent of the suspended solids will go into the river water."

Greeley & Hansen, engineers on the sewer project, Mr. Boasberg charged, are being paid more than $500,000 for using plans and data prepared by George B. Gascoigne, Cleveland engineer, at a cost to the city of $100,000 ten years ago.

Mr. Boasberg also asserted that "the engineers and the clique in the authority have adopted methods which are recognized as rapidly becoming obsolete, such as the plan requiring the utilization of detention tanks, wherein the sewage sludge is held for weeks while undergoing violent putrefaction, as against the modern method of the continuous and immediate dewatering and incineration of sewage before odors and putrefaction have had time to generate."

Engineers answer charges

Greeley & Hansen, in a letter to the sewer authority, asserted that Mr. Boasberg's charges were "erroneous and misleading." The letter stated that "there is no proposal to bypass 60 per cent, or any per cent, of sewage into the Niagara River. There is no intention of using a bypass at the sewage treatment works except during very heavy storms, such as occur not oftener than once in fifty years.

"Chlorine treatment will be applied to all of the sewage . . . bacterial effectiveness of the plant will be much greater

(*Continued on page* 462)

Water Conservation and Pollution Studied by Municipal Engineers

ADMINISTRATIVE, legal and technical phases of water conservation and stream pollution were discussed at a conference of the New Jersey Association of Municipal Engineers, held in Trenton, N. J., on March 19, in which more than 175 engineers and public officials took part. Keynoting the purpose of the meeting, Governor Harold G. Hoffman, called upon engineers of the state for active leadership in the formulation of a sound program of water development in New Jersey to avert threatened supply shortages; he also urged the promotion of stream clean-up programs.

Thorndike Saville, dean, college of engineering, New York University, member of the Water Resources Committee, stated that stream pollution control was one of the first things to be considered in water conservation. He pointed out that significant advances in pollution abatement had been made in the last five years but that future progress depended upon closer coordination of local, state and regional agencies toward the solution of interrelated problems in an entire drainage basin. To this end a federal agency to investigate, guide and report on problems would be helpful. However, said Dean Saville, this did not imply that the federal government should in any way assume powers of regulation or administration of stream pollution control. The latter are strictly state functions for which effective agencies already exist, and whose powers can be expanded by means of compacts to cover interstate problems.

New York State problem

Progress in New York toward the abatement of stream pollution was traced by A. F. Dappert, principal sanitary engineer in the division of sanitation, state department of health. Since 1903, when the first law was passed relating to discharge of sewage into water courses, educational effort rather than legal coercion, by the health department, has been the principal means of stimulating sewage treatment plant construction. There were only three disposal plants in the state in 1903 but today there are installations operating in 240 municipalities, 30 institutions, and at numerous industrial establishments. Despite all this progress, much remains to be done; the volume of untreated sewage is still as great as that which is being treated. Mr. Dappert stated that New York is cooperating with other states in furthering interstate action on pollution abatement; he mentioned the existing Tri-State compact and pending agreements in the Delaware and Ohio river basins.

New Jersey's problem

An important aspect of sewage and industrial waste pollution concerns the shell fisheries in New Jersey, according to Prof. T. C. Nelson, of Rutgers University. He reviewed the economic damages that have already occurred in some parts of the state where oyster harvesting is a major industry.

The water problem in New Jersey is one of population concentration rather than engineering difficulty, said Nathan B. Jacobs, consulting engineer of Pittsburgh. Mr. Jacobs' observations were based on a report of the North Atlantic Drainage Basin, of which New Jersey is a part, which he prepared for the National Water Resources Board. The situations in both the northern and southern metropolitan areas of New Jersey—where supply shortages are threatened because unified planning is lacking—were held up as warnings to other communities to make adequate preparation for water development.

Howard G. Critchlow, engineer of the State Water Policy Commission, predicted a water shortage in northern New Jersey by 1943-45 unless new sources of supply were immediately developed. Other parts of the state were stated to be relatively better off with regard to reserve supply because competition for undeveloped sources is not so keen. Mr. Critchlow recommended the formation of metropolitan districts under control of a state commission, as the most feasible manner of meeting the water demands of densely populated New Jersey; at the present time there are 242 independent water systems in the state.

The part that the city engineer can play in promoting unanimity of action in water supply development was stressed by Frederick O. Runyon consulting engineer. He urged city engineers to properly appraise their public officials with the need for new supplies and, wherever possible, extend large water mains to town lines so that interconnections with other systems can easily be made in case of emergencies.

A. M. Byers Photo

WROUGHT IRON TRASH RACK FOR FORT PECK TUNNEL

TRASH RACKS for the four diversion tunnels at the Fort Peck Dam in Montana were specified to be made of wrought iron by the U. S. Engineer Office in Kansas City. About 400 tons of wrought iron bars, plates, channels and angles are required for the racks, one of which is shown being fabricated by arc welding in the plant of the St. Louis Structural Steel Co. The trash racks are rectangular in shape, and range in size from 6 ft. 8 in., x 9 ft. 3 in., to 12 ft. 1 in., x 8 ft. 6½ in. Of the total of 241 required, 70 will be placed in a vertical position, and the balance will be installed flat.

Wage Rises on Tunnel Project In Negotiations with CIO

Wage increases amounting to nearly $1,500,000 annually were granted to 8,000 workers on the San Jacinto tunnel project by the Metropolitan Water District of Southern California after weeks of negotiation with organized labor groups represented by the Committee for Industrial Organization.

Provisions of the agreement include:

A general increase of 50 cents a day in all present rates and a minimum rate of $5.00 a day.

All underground workers in the tunnel project on daily pay rates to receive a dollar a day increase.

All salaried employees at Banning receiving $190 or less to receive an increase of $15 a month.

Demands of the union for seniority rights and a blanket dollar a day increase for all district employees were rejected.

Work on the tunnel project has continued steadily despite sporadic labor disputes since the first of the year.

Buffalo Sewer Authority Member Resigns

(*Continued from page* 461)

than 70 per cent. . . .

"Ninety-five per cent of the settleable solids will be removed and destroyed by incineration. There will be no noticable pollution of the Niagara River.

"To arrive at the conclusions on which the design of the proposed project were based, it was of course necessary to make use of all available information of record, and it was understood from the beginning that such information, including the Gascoigne report, would be available to any engineer selected by the authority. While this data was not oriented to specific design, it was, nevertheless, helpful."

Charles R. Velzy, resident engineer for the firm of Greeley & Hansen, commenting at more length, on March 20, on Mr. Boasberg's assertion that 60 per cent of the suspended solids would go into the river, stated that the figure is closer to 50 per cent than 60 and emphasized that it will be sterile liquid, somewhat discolored, but not solid matter in the ordinary use of that term. "The solids," he explained, "are in solution and may be described as solids only in the scientific sense. All of the sewage is chlorinated as it enters the treatment plant. After being chlorinated, the thin liquid, which has now become sterile, goes into the river, while the heavier deposits, called sludge, proceed to the sedimentation tank. . . . All of the solids large enough to be visible to the naked eye are incorporated in the sludge."

Faulty Construction Causes School Roof Collapse

The collapse of a portion of the concrete roof of the Benjamin Harrison School in Kansas City, Mo. (*ENR*, Feb. 25, 1937, p. 317) resulted from negligence in construction and inspection, according to N. W. Downs, chief engineer and superintendent of city school buildings.

Brick masons built the supporting walls about three courses too high, and the contractor, in forming the 12-in deep roof joists which were to bear on the wall, failed to remove these extra courses. For the bottom 7 or 8 in. of depth, the joists therefore merely abutted against the walls, leaving only a 4 or 5 in. thickness to extend over the walls. This thickness was all that was available to resist shear. Furthermore, the top reinforcing rods extended an inadequate distance over the wall; the bottom rods were entirely ineffective. The joists failed in shear after ten years of exposure to moisture infiltration and temperature movement had weakened them and the 3 in. slab roof that they supported. The opposite ends of the joists were framed properly.

Tests of four samples of the concrete gave results ranging from 1,642 to 3,065 lb. per sq.in., averaging 2,281 lb. per sq.in. "The question of inferior concrete was therefore not a factor in causing the failure," Mr. Downs concluded.

Ground Broken in Chicago for Public Administration Center

Ground was broken on March 15 for the new public administration building on Chicago University property to house 14 autonomous associations of public officials and to be known as the "Public Administration Center." Louis Brownlow, director of the Public Administration Clearing House, one of the associations that will occupy the new building, turned the first shovel of dirt in the ground-breaking ceremony. Funds for the erection and administration of the building were given the University of Chicago by the Spelman Fund of New York to assist the groups that are working on problems of administering the public business, as distinct from governmental problems of policies and politics. The building will cost $650,000, and will be completely air conditioned. The architects are Zantzinger & Borie, Philadelphia, with Emery B. Jackson acting as associate. The general contract is held by the William J. Lynch Co., and completion is scheduled for early in 1938. Four stories in height, the building will have 22,000 sq. ft. of office space.

Labor Relations Act Upheld By Circuit Court

The constitutionality of the National Labor Relations Act as regards interstate commerce was upheld for the second time by the U. S. Fifth Circuit Court of Appeals at New Orleans on March 18 in an opinion reversing the decision of federal judge Boynton of El Paso, Texas, who had held the act unconstitutional and had permanently enjoined the Labor Relations Board from enforcing the act against the El Paso Electric Co.

Granting of the Texas injunction followed lengthy hearings held by the NLRB on charges of unfair practice brought against the El Paso Electric Co. The company, which has its main power plant in New Mexico, sell less than 5 per cent of its power in New Mexico and to Mexican electrical companies, the remainder being utilized in El Paso, Texas.

Holding that an act of Congress should not be outlawed unless invalid beyond any reasonable doubt, the circuit court said:

"In many operations beside railroad transportation, labor troubles can, and Congress has found in the recitals of the act that they do, impede and hinder directly interstate commerce actually in progress. . . .

"We think the [lower] court erred, because a legislative act should not be declared void unless its unconstitutionality appears beyond every reasonable doubt and such a ruling is necessary to the disposition of the case."

SOCIETY CALENDAR

AMERICAN SOCIETY OF CIVIL ENGINEERS, spring meeting, San Antonio, Texas, April 21–24.

NATIONAL RIVERS AND HARBORS CONGRESS, annual convention, Washington, D.C., Apr. 26-27.

BUILDING OFFICIALS OF AMERICA, annual convention, Cleveland, Ohio, week of May 31.

AMERICAN WATER WORKS ASSOCIATION, INDIANA SECTION, Indianapolis, Ind., March 25–26.

AMERICAN WATER WORKS ASSOCIATION, FLORIDA SECTION, Ocala, Fla., March 30–April 1.

ARKANSAS WATER WORKS CONFERENCE, annual conference, Fayetteville, Ark., April 12–14.

AMERICAN WATER WORKS ASSOCIATION, KENTUCKY-TENNESSEE SECTION, and SOUTHEASTERN SECTION, joint meeting, Chattanooga, Tenn., April 5–7.

GREATER NEW YORK SAFETY COUNCIL, annual convention, New York City, April 13–15.

AMERICAN WATER WORKS ASSOCIATION, CANADIAN SECTION, Montreal, Canada, April 14–16.

AMERICAN WATER WORKS ASSOCIATION, MONTANA SECTION, Lewiston, Mont., April 19–23.

AMERICAN WATER WORKS ASSOCIATION, FOUR STATES SECTION and PENNSYLVANIA WATER WORKS OPERATORS ASSOCIATION, joint meeting, Philadelphia, Pa., April 22–23.

AMERICAN WATER WORKS ASSOCIATION, ILLINOIS SECTION, Springfield, Ill., April 29–30.

NORTH CAROLINA INDUSTRIAL SAFETY CONFERENCE, Winston-Salem, N. C., May 20–21.

AMERICAN WATER WORKS ASSOCIATION, PACIFIC NORTHWEST SECTION, Victoria, B. C., May 20–22.

NEW YORK STATE SOCIETY OF PROFESSIONAL ENGINEERS, annual meeting, New York City, May 22.

At the January 23 meeting of the LOUISIANA ENGINEERING SOCIETY, the following officers were elected: President, Charles A. Williamson; first vice president, B. H. Grehan; second vice president, Leo J. La Salle; secretary-treasurer, A. M. Hill; members of the board of directors, L. L. Newman and C. G. Cappel.

Personals

V. J. BEDELL has been elected general manager and chief engineer of the New Orleans Public Belt RR.

E. A. ROLFSON resigned his position as principal engineer, REA, to become county manager of San Mateo County, Calif.

J. C. BAKER and JOHN E. BUXTON announce the formation of the Baker-Buxton Engineering Co., consulting engineers, Little Rock, Ark.

D. G. MCGORY, formerly of Seattle, Wash., has been named city engineer, water department manager and street supervisor of Anacortes, Wash.

WM. A. COSTELLO has been appointed engineer for Skagit County, Wash. He was formerly district engineer for WPA at Everett, Wash.

W. P. NORRIS, senior engineer for WPA, Ft. Dodge, Iowa, has resigned to become county engineer of Appanoose County, Centerville, Ia.

HAL J. JENNINGS, formerly project engineer of the Indiana Highway Commission, has been appointed assistant engineer in the dams division of the Bureau of Reclamation at Denver.

Miami Beach to Lay Long Sewer Outfall

A sewer outfall extending about 7,000 ft. into the ocean is to be laid by the city of Miami Beach, according to an announcement just made. The official proposal advertisement, received too late for publication in this issue, will appear next week. Bids are to be opened on April 21, 10 A.M. EST. The outfall, of 36-in. flexible-joint cast iron pipe, will have its first 700 ft. outboard from the steel sheetpile beach bulkhead laid between sheeting in order to place the pipe in the coral rock bottom and excavate sand without disturbing the beach; thence outward the pipe will be in coral rock trench to its outer end, which is in 40 ft. depth of water. In rock trench the pipe is to have tremie concrete support and backfill. The outer 500 ft. will contain six 16-in. diffuser outlets.

Appurtenant work includes placing a steel sheetpile bulkhead braced with timber, and two groins extending out about 250 ft., between 73rd and 75th Sts., Miami Beach.

Drawings, specifications, contract forms, etc., may be obtained from the city engineer or from Malcolm Pirnie, consulting engineer, 25 West 43rd St., New York, for a deposit of $25, returnable. Any and all bids may be rejected.

Separate bids are asked for laying the pipe and for supplying the pipe and special castings required for the outfall and some associated improvements in the sewer and water systems. About 7,500 tons of pipe are required, the largest part 30- and 36-in. pipe, the later with flexible joints. It is to have bituminous lining, except that some of the water pipe may have cement or bituminous lining. A certified check for 2½ per cent is required on the pipe bids, 4 per cent on the bid for laying.

Obituary

MICHAEL J. ROACH, 70, railroad and levee contractor for many years at Memphis, Tenn., died there on March 15.

MARCUS T. REYNOLDS, Albany architect and an authority on slum clearance and public housing, died March 18 in Albany at the age of 67. Mr. Reynolds was the author of Albany's first building code and the designer of numerous buildings, public and private, in Albany.

DANIEL W. MCGRATH, a former building contractor at Columbus, Ohio, died there March 19 at the age of 82. Mr. McGrath built Columbus' first skyscraper, the Wyandotte building, and also the First National Bank Building there. He retired in 1933.

GEORGE RAYNER, civil engineer and surveyor of Yonkers, N. Y., died March 17 there at the age of 77. He was early associated with the engineering firm of George Rayner & Sons, founded by his father, and was a member of charter commissions that prepared city charters for Yonkers.

JAMES R. GORDON, New York City architect, died there last week at the age of 74. A specialist in the field of public buildings, Mr. Gordon had designed a number of state capitols, including those in Arizona and Montana, 72 courthouses, and many banks, hotels, churches, prisons, hospitals, and other institutions in various parts of the country. Mr. Gordon was on the staff of the U. S. Supervising Architect and was president of the Council of Registered Architects of the state of New York.

LEWIS M. HAUPT, consulting engineer and former professor of civil engineering at the University of Pennsylvania, died in Philadelphia on March 10, aged 92. After some undergraduate work at Harvard, Mr. Haupt attended West Point and was graduated in 1867. Several years service with the Engineers Corps and work for the city of Philadelphia and the U. S. Patent Office followed and he then became professor of civil engineering at the University of Pennsylvania, which position he held for 20 years, (1873-1893). During this time he was also engineer of the fourth lighthouse district, assistant in the coast survey in charge of the geodesy of Pennsylvania, and was one of the commissioners on the Lake Erie and Ohio River ship canal. At the end of his service at the University of Pennsylvania, Mr. Haupt entered private practice, practicing actively until his death. During this period he served on the Nicaraguan and Panama canal commissions. He was the first president of the engineers club of Philadelphia.

LARGER AWARDS FOR THE WEEK

Factory, Crown Can Company, St. Louis, Mo.	$3,500,000
Factory, Trico Products Corporation, Buffalo, N. Y.	600,000
Rolling mill, Bridgeport Brass Company, Bridgeport, Conn.	4,000,000
Turbine for steam generating plant, Rochester Gas and Electric Corporation, Rochester, N. Y.	1,000,000
Light plant, Toledo Edison Company, Toledo, O.	200,000
Warehouse, Congoleum-Navin, Inc., Marcus Hook, Pa.	500,000
Apartment, Corporation care of D. Buchell, Forest Hills, N. Y.	1,250,000
Fourteen six-story apartments, Farmers Estates Corporation, Forest Hills, N. Y.	2,000,000
Apartment, East Orange, N. J.	500,000
Refrigerating and air-conditioning department store, J. L. Hudson Company, Detroit, Mich.	1,500,000
Air conditioning offices, Philtower and Philcade, Tulsa, Okla.	600,000
School, Appleton, Wis.	783,000
Additional stories, pent houses, etc., Federal Office Building, New York, N. Y.	2,300,000
Constructing substructure and superstructure on American span on bridge over St. Lawrence River between New York and Canada; also substructure and superstructure on Canadian span, Thousand Islands Bridge Authority, New York and Canada	2,011,000
Shafts 4, 5, 5A and 6, Rondout West Branch Tunnel—shafts 7, 8, and 9 Uptake and 9 Downtake, Contract No. 334, New York, N. Y.	4,220,000
Sewage incinerator equipment, Detroit, Mich.	518,000
Sewers—Bridge, Martin and 21st Streets, PWA Loan, Omaha, Neb.	1,070,000
Pumping station, grit chambers, etc., at sewerage treatment plant West Jefferson Avenue and River Rouge	1,480,000

INDEX NUMBER

ENR Cost	1913 = 100	1926 = 100	ENR Volume	1913 = 100	1926 = 100
Mar., 1937	225.25	108.18	Feb., 1937	181	79
Feb., 1937	223.45	107.41	Jan., 1937	167	73
Mar., 1936	201.20	96.71	Feb., 1936	176	77
1936 (Av.)	206.46	99.24	1936 (Av.)	185	81
1935 (Av.)	195.22	93.84	1935 (Av.)	135	58
1934 (Av.)	198.10	95.23	1934 (Av.)	114	50

CONTRACTS

(Thousands of Dollars)

	Weekly Average Mar. 1936	Weekly Average Prev. 4 Weeks	Week Mar. 25 1937
Fed Government.	$1,985	$3,863	$4,162
State and Municipal	20,702	12,111	19,146
Total public	$22,687	$15,974	$23,308
Total private	14,237	29,016	25,698
Week's total	**$36,924**	**$44,990**	**$49,006**

Cumulative to date:
1936 (13 weeks) $600,743,000
1937 (12 weeks) $519,662,000

Note: *Engineering News-Record* reports waterworks and earthwork, reclamation or waterways projects of $15,000 and over in size; other public works, $25,000; industrial buildings, $40,000; other buildings, $150,000 and over. The figures above represent the volume of contracts and large force account projects throughout the U. S. that are of these minimum sizes or over.

NEW PRODUCTIVE CAPITAL

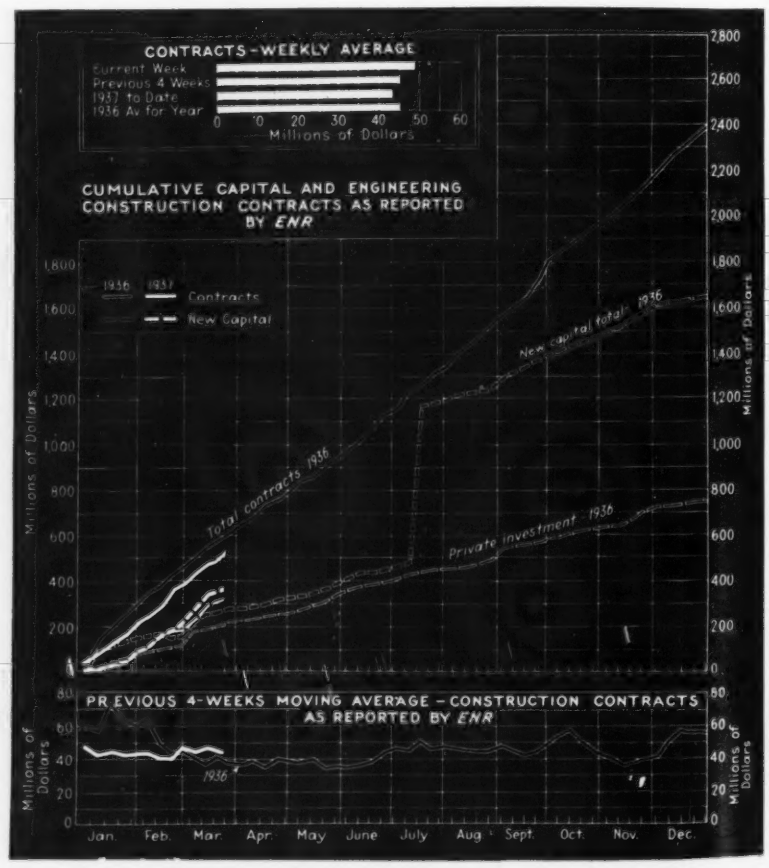
(Thousands of Dollars)

1937	Week Mar. 25	Cumulative
Private investment	**$29,031**	**$330,925†**
State and municipal bonds	4,041	138,793†
Corporate securities	24,990	192,132
Federal financing	.....	**$46,569**
PWA non-federal Projects	.....	46,569
Total non-federal	**$29,031**	**$377,494**
Federal projects	.....	.....
Total	**$29,031**	**$377,494**

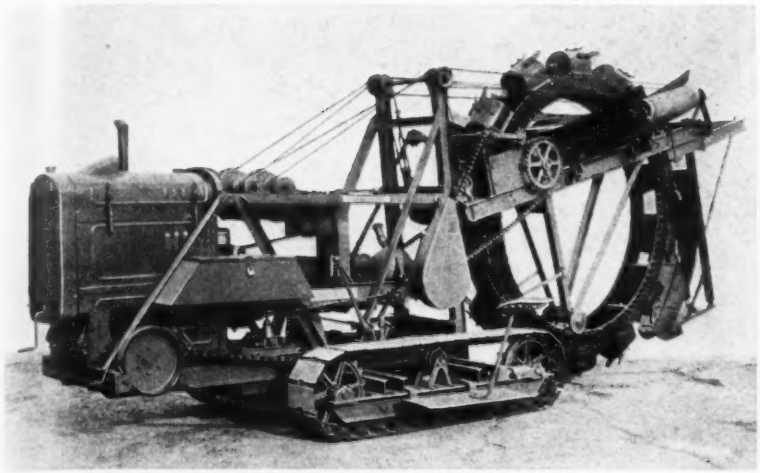
Cumulative to date:
1936 (13 weeks) $300,183,000
1937 (12 weeks) $377,494,000

Note: These figures include private bonds and stocks sold for new construction purposes; state and municipal bonds for construction; PWA loans and grants to states and municipalities, RFC direct purchase of bonds for "self liquidating" projects, and 25 per cent of WPA construction appropriations.

† Includes transfer from federal to private investment financing through sale by RFC of PWA bonds.


CONTRACTS - WEEKLY AVERAGE
Current Week
Previous 4 Weeks
1937 to Date
1936 Av. for Year
0 10 20 30 40 50 60
Millions of Dollars
CUMULATIVE CAPITAL AND ENGINEERING CONSTRUCTION CONTRACTS AS REPORTED BY ENR
1936 1937
Contracts
New Capital
New capital total 1936
Total contracts 1936
Private investment 1936
Millions of Dollars
PREVIOUS 4-WEEKS MOVING AVERAGE - CONSTRUCTION CONTRACTS AS REPORTED BY ENR
1936
Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.

Construction Equipment and Materials



New Cleveland Ditcher

The new Model 110 ditcher of the Cleveland Tractor Company is said to be especially built to meet the needs of pipe line companies and contractors. It will cut a trench 10½ to 23 in. wide to a maximum depth of 5½ ft., at digging speeds ranging from 1½ in. to 33 ft. per minute. Power is furnished by a 325 cu.in. gasoline engine developing 38.5 hp.

Distinctive features of this machine are said by the manufacturer to be the enclosed dirt-sealed drive; differential brake steering; quick-shift arc type conveyor; close-up view of digging action from operator's platform; and a wide use of alloy heat-treated steels.

The maximum road speed of the machine is 3 m.p.h., and, having a total weight of less than 6 tons, it can be loaded on a specially-built trailer, it is claimed, in 10 or 15 minutes or unloaded in a similar time.

Brown Line Enlarged

The new line of Brown Hancock valves, manufactured by the Hancock Valve Division of the Consolidated Ashcroft Hancock Company, Bridgeport, Conn., now includes 1¼ in., 1½ in. and 2 in. sizes. Sizes 1 in. and smaller were put on the market a year ago.

This new line of Hancock valves is distinguished, according to the manufacturers, by the exceptionally hard stainless steel seats and disks with which they are equipped. The trim in these valves is heat-treated to a hardness of 500 Brinell. The makers claim that this hardness enables the valve to smash nails, pipe fittings, boiler scale, and sand without marking either the valve seats or the disks.

New Equipment Brief

Indicator—Bearing protection is said by the Eskalin Company, New York City, to be provided by their new paints which have the property of changing color when exposed to heat. Some of the paints will turn back to the original color when cooled and others will remain permanently changed. A series of five permanent-change paints and seven retroactive-color paints are available. The former change at temperatures ranging from 300 deg. F. to 734 deg. F., the latter at temperatures from 104 deg. F. to 464 deg. F., with a safety margin of 25 deg. The manufacturer states that the temperature changes are clear and unmistakable even at some distance from the machine.

Pump—a pump which is especially adapted, according to the manufacturers, for contractor's use as an all-round utility pump has been developed by the Sterling Machinery Corp. The new Model 7-M 6,000 gal. per hour pump is equipped with a Wisconsin single cylinder air-cooled Model AB gasoline engine developing 2½ to 3 hp. and is furnished with an independent outside high tension magneto.

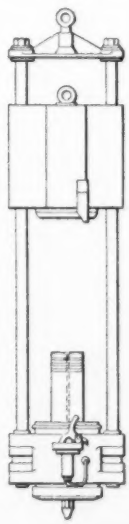
Guarantee—The mileage guarantee for Goodrich Kathanode batteries used in commercial service has been increased, it is announced by the B. F. Goodrich Company, Akron, Ohio. On all heavy duty Goodrich Kathanode batteries for trucks and batteries, the guarantee has been raised from 18 months or 36,000 mi. to 18 months or 72,000 mi. The guarantee on commercial type batteries for light trucks has been raised from 18 months or 36,000 miles to 18 months or 54,000 mi.

Culvert cleaner—A simple tool for removing dirt from filled or partly clogged culvert and drain pipe, the Morco Culvert Cleaner, is manufactured by the Monarch Road Machinery Company, Grand Rapids, Mich. The device consists of a large shovel with a hinged hoe in front, slanting from the top toward the rear of the shovel. When the shovel is moved forward the pressure of the earth causes the hoe to rise and admit the earth; when the shovel is drawn back the hoe drops and holds the earth in the shovel. The handle is made up in sections of ¾ in. water pipe and can be extended to any desired length.

Diesel Pile Driving Hammer

A pile driving hammer operating on the diesel principle is being manufactured by C. H. Johnson & Sons, Ltd., Manchester, England, according to the English magazine *Engineering*. The device has very few moving parts and is claimed to be highly economical.

The ram of the hammer, moving up and down on fixed guides, is hollow and acts as a cylinder. A piece extending from the anvil and shaped to fit the hollow in the ram is a fixed piston. During the lower part of its travel, the hollow ram covers the piston and compression is effected as it moves downward. Just before the ram reaches the anvil a striker comes in contact with a fuel injection pump lever, actuating the pump and forcing



oil up through an internal passage to the cylinder head where it is discharged through a jet. The charge fires, and the explosion throws the ram to the top of its travel, the process being repeated so long as the fuel supply continues.

The height of the jump can be regulated by a hand cable attached to the fuel pump, by which the fuel supply can be controlled. No special cooling arrangements are necessary since the piston is continually being exposed to the air.

Starting is accomplished by hauling the ram to its highest position, where it is engaged by a catch. The lifting rope is then disconnected, and the ram is allowed to fall, upon which the device is said to start immediately.

New Publications

✦ A multitude of striking photographs of precise machine processes are included in the 65 pages describing *Precision Methods* used by the INTERNATIONAL HARVESTER CO., Chicago, Ill., in building TracTracTors.

✦ *Company Facts*, a new booklet issued by the ALLIS-CHALMERS MFG. CO., Milwaukee, Wis., after a brief history of the company, devotes a section to each of the types of equipment, ranging from hydraulic turbines to tractors, manufactured by the company.

✦ DeLaval motor-mounted pumps are described in a catalog issued by the DELAVAL STEAM TURBINE CO., Trenton, N. J. These are units consisting of a centrifugal pump mounted directly upon the frame of an electric motor with only one shaft and two bearings in the assembly. Dimensions and other details are given for pumps of capacities from 5 to 1200 gal. per min. for heads from 10 to 230 ft.; pipe friction tables and instructions for selecting and installing pump units are included.

✦ A catalog in pictures, *Pictorial Reference Catalog-1655*, of road making, earth handling, rock crushing, and street cleaning equipment has been issued by the AUSTIN-WESTERN ROAD MACHINERY CO., Aurora, Ill.

✦ A very complete catalog, *No. 12-C*, of hoists, trolleys and cranes has been issued by the WRIGHT MFG. DIVISION of AMERICAN CHAIN CO., York, Pa. Besides specifications on Wright hoists, trolleys, and cranes, the catalog includes suggestions on choosing a hoist, and design tables for trolleys, cranes and I-beams.

✦ *A Manual of Factory Lighting Practice*, issued by the BENJAMIN ELECTRIC MFG. CO., Des Plaines, Ill., chooses 30 typical problems in the lighting of factory sites and indicates solutions in non-technical language, photographs, and diagrams. An introductory section outlines the procedure to be followed in analyzing any lighting problem.

✦ A new pocket-size 233-page handbook, *Engineering Data and Prices, 1937*, has been issued by the ECONOMY PUMPING MACHINERY CO., Chicago, Ill. The first section of the handbook is a catalog of the various classes of pumps manufactured by the company and a use index to aid in the selection of the proper pump. A second section of the book gives specific information on the hydraulics of pumping and related technical articles and tables.

✦ *Good Roads*, a 52-page pamphlet issued by the BARBER-GREENE CO., Aurora, Ill., points out in an interesting and attractive manner Barber-Greene's contributions to the art of road building. A complete catalog of the company's road building equipment is included.

✦ The NELA PARK ENGINEERING DEPARTMENT of GENERAL ELECTRIC CO., Cleveland, Ohio, in a new booklet, *Lighting for Seeing in the Office*, analyzes this subject on the basis of the requirements for casual seeing, for usual seeing, and for critical seeing.

✦ The ROBINS CONVEYING BELT CO., New York City, has issued a pamphlet on screen cloth for vibrating screens, *Bulletin No. 98*.

✦ SMITH ENGINEERING WORKS, Milwaukee, Wis., has brought out a new bulletin, *Telsmith Portable Crushing Plants*, describing various combinations of Telsmith equipment which may be assembled to make portable crushing units.

✦ *Intermediate Type Asphalt Roads*, a new bulletin of the TEXAS CO., New York City, gives rather detailed directions and quantity tables for the use of Texaco road-surfacing materials.

✦ A pocket-size solidly bound handbook, *Koppers Tarmac Handbook*, issued by the TAR AND CHEMICAL DIVISION of KOPPERS CO., Pittsburgh, Pa. gives very complete quantity tables, instructions, and specifications for Tarmac road construction and maintenance.

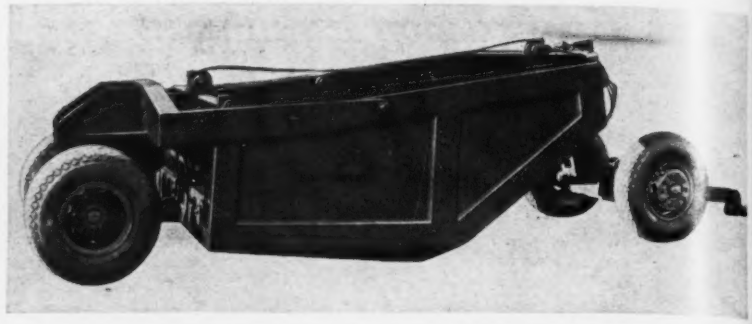
✦ The use of Solvay calcium chloride in fire fighting equipment is described by the SOLVAY SALES CORP., New York City, in a little pamphlet, *All's Well*.

✦ *Catalog 25* of the AMERICAN CEMENT MACHINE CO., Keokuk, Iowa, describes Boss mixers, hoists, concrete carts, and dump bodies.

✦ A new catalog has recently been issued giving information on the complete line of Allis-Chalmers road-patrols. The ALLIS-CHALMERS MFG. CO., Milwaukee, Wis., devotes several pages of the catalog to the tandem drive models brought out early in 1936. Details are also given on the controlled ignition diesel fuel engine which has been used for several years in the company's tractors.

✦ A new catalog, *Oster Williams Threading Equipment*, covering the entire line of Oster Williams pipe and bolt threading equipment and welding equipment, was issued recently by the OSTER MFG. CO., Cleveland, Ohio.

✦ The BABCOCK & WILCOX CO. of Beaver Falls, Pa., has appointed W. W. Williams, formerly general sales manager, as general manager of the company; T. F. Thornton has been appointed general sales manager.



WELDED FRAME ON SOUTHWEST SCRAPER

The Southwest Welding & Manufacturing Company, Alhambra, Calif., have simplified the design of their Southwest carry scraper. Capacities remain at 6, 8, 10 and 12 cu.yd., but the frame structure has been changed from the I-Beam type to the welded box type, eliminating projections and, the manufacturers state, giving added strength with less weight than formerly.

Drawbridge Marker Uses Silico-Aluminum Castings

A drawbridge marker, for drawbridges, deck, pontoon, bascule, and retractile bridges, complying with U. S. Lighthouse Bureau requirements is being produced by the Westinghouse Co., East Pittsburgh, Pa. The 360-deg. white Fresnel lens, with red convex panels in two opposite sides and green convex panels in intermediate sides, throws the light from each panel over not more than 60 deg. of the horizon.

The base, lens ring, cover and panel frame are cast of non-corrosive silico-aluminum. The Fresnel lenses are seated on cork gaskets and sealed in with plastic compound. The covers seat on felt gaskets, sealing the unit against dust and weather. The color panels seat on felt gaskets and are held in place by spring bronze clips. The medium-screw porcelain socket is mounted on a shock absorber and uses a 50-watt clear lamp or 60-watt traffic signal lamp. Cast aluminum parts are finished with metallic aluminum paint. All external fittings are bronze or bronze nickel-plated, except the wing screws which are cadminum plated, and all internal fittings are cadmium plated.